INDUSTRIAL PSYCHOLOGY AND THE PRODUCTION OF WEALTH

INDUSTRIAL PSYCHOLOGY AND THE PRODUCTION OF WEALTH

BY

H. D. HARRISON

M.C., M.Com.

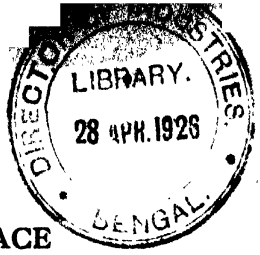
METHUEN & CO. LTD
36 ESSEX STREET W.C.
LONDON

First Published in 1924

PRINTED IN GREAT BRITAIN

TO

MRS. MARY B. DEWSBURY



PREFACE

INDUSTRIAL Psychology and the Production of Wealth deals with one process only in the complicated series by which our wants are more or less adequately supplied —production in the narrow sense of manufacture. Great as would be the advantages of the application of science to this one process, there is an even greater need for its application to certain of the other processes of our economic life. There is need for the careful investigation of the savings which could be brought about by the scientific distribution not only of the products of industry (technically a phase of production), but also of the profits thereof. The economic waste in each of these processes to-day is colossal. In the case of the distribution of products the classical example of the wasteful method of distributing milk in our great towns, as compared with the distribution of letters, may be cited. A hundred examples could be given of wasteful distribution of the profits of industry, of the giving of great rewards for little or no personal service in some cases and of rewards inadequate to provide an incentive, or even the necessary

physical well-being, for efficient service in others.

There is a tendency to eulogise too much the complicated machinery by which raw materials are brought from all parts of the world, manufactured and distributed, ready for use, to the consumer, and to excuse defects on the grounds that, at any rate, " it delivers the goods." Since the war broke out more and more serious defects have become apparent—it is doubtful if it can rightly be said even " to deliver the goods " at present, and those which it does deliver it does so at a tremendous cost of human effort and with great loss of power. Several of these defects have been touched upon incidentally, especially in the last two chapters of this book. They call for scientific investigation and careful, systematic modifications in our economic structure. Unless these matters are attended to there can be little hope of advancing far towards the realisation of the ideal of the ample provision for human needs with the least possible expenditure of human effort.

H. D. HARRISON

ANGLO-JUGOSLAV CLUB,
BEOGRAD,
August, 1924.

CONTENTS

CHAPTER IV

MOTION STUDY AND THE ADJUSTMENT OF MATERIAL CONDITIONS TO THE WORKER

CHAPTER V

VARIOUS PSYCHOLOGICAL FACTORS AFFECTING INDUSTRY

CHAPTER VI

CONCLUSION

N.B.—The following abbreviations are used throughout :

N.I.I.P.J. = The Journal of the National Institute of Industrial Psychology.

I.F.R.B. = Report of the Industrial Fatigue Research Board.

INDUSTRIAL PSYCHOLOGY AND THE PRODUCTION OF WEALTH

CHAPTER I

INDUSTRIAL PSYCHOLOGY AND SCIENTIFIC MANAGEMENT

"THE knowledge of causes and secret motions of things; and the enlarging of the bounds of human empire, to the effecting of all things possible"[1] was the not ignoble aim which Francis Bacon, the great father of modern science, set for himself and his followers. In the pursuit of that aim the thinkers of some three centuries have revolutionised man's ideas of himself and his environment, and have endowed their posterity with achievements more useful and more marvellous than all those of which the previous history of mankind—

[1] *New Atlantis*, an unfinished work, written *circa* 1623.

with its thousands of years, the rise and fall of civilisations and dynasties and the drums and tramplings of innumerable conquests—bears record. The scientists of to-day are pressing forward towards the same goal even more swiftly than their predecessors.

One important indication of the rapidity of intellectual progress is that it has become a truism to say that fundamentally there is but one science of the universe. There seems to be a kind of Tom Tiddler's ground on which the most advanced thinkers in every science ultimately find themselves to be trespassing,[1] a common centre upon which artists and scientists alike, starting from the most widely different premises and with apparently very diverse aims, find themselves converging and to which the general name of Philosophy is commonly given.[2] Thus in the recent investigations[3] into the structure of the atom the physicist, chemist, mathematician, mechanician and metaphysician have all been

[1] Cf. T. H. Pear "The Applications of Psychology to Industry" in *Industrial Administration*, p. 25, "As sciences progress they tend to smudge their own border lines." Cf. also McDougall *An Introduction to Social Psychology*, p. 6.

[2] Cf. Viscount Haldane's *Address, N.I.I.P.J.*, p. 66.

[3] Cf. Bertrand Russell, *The New Leader*, Feb. 9–Mar. 9, 1923.

engaged with remarkable success; while Mr. de la Mare has portrayed Poetry gazing fearlessly into the eyes of "shaggy Science nosing in the grass" and laughing aloud to find reflected "In those grey deeps the azure of her own."[1]

Until man knows everything about everything, then, he will never know everything about anything; and the realisation of this essential unity of knowledge may explain, and so put us on our guard against, the grave dangers both for science and for humanity which seem to result from comparatively great advances in one or two branches of science unbalanced by corresponding progress in other fields of human knowledge. The scientific discoveries and mechanical inventions of the eighteenth century exploited by the baser passions of selfishness and greed, and unaccompanied by any of the knowledge of psychology and physiology and undeterred by political, social or humanitarian considerations, produced the squalor and misery of the Industrial Revolution.[2] And to-day some of

[1] Walter de la Mare, *The Happy Encounter*, poems, 1901–1918, Vol. I, p. 73.

[2] Cf. also *Industrial Efficiency and Fatigue*, p. 16.

our publicists[1] are warning us that the enormous increase in man's control over physical force which is a distinguishing feature of recent years, if unaccompanied by a widespread improvement in the education and moral character of mankind, may end in the self-annihilation of civilised society.

Hence we cannot but be thankful for any tendencies in modern scientific thought which promise to redress the balance overweighted by previous concentration on only one or two aspects of human knowledge. The nineteenth century was the Age of Mechanics; the twentieth bids fair to become noteworthy as the Age of Psychology. But recently acknowledged as a science, Psychology has extended its sway from the conscious states of the human mind, to which it was limited a decade or so ago, over the realms of the subconscious and even the unconscious. It has shown the inter-relation between body and mind to be far more wonderful, more complicated and more subtle than would have been credited by either the psychologist or the physiologist of the nineteenth century. It has invaded the

[1] e.g. H. G. Wells, *The Salvaging of Civilisation*; Norman Angel, the Webbs and the late Frederic Harrison.

realms of art—do not our shelves groan under the burden of psychological novels which trace through sequel after sequel the history of one man's schooldays and adolescence and leave him still in his prime after traversing half a dozen weighty volumes?[1] A few months ago our bookshops were besieged by people who wanted works on Psycho-Analysis and dream-interpretation; while Freud's name is for ever on the tongues of modern educationists.

It is not surprising, then, to find that the psychologist has entered the factory with his apparatus, his tests and his notebook, and has begun to apply to industry the new and highly specialised knowledge of human behaviour and the functioning of the mind of man which the new psychology[2] has made available.

The applications of psychology to industry are literally innumerable, and it is no exaggeration to say that, scientifically applied, this new knowledge will revolutionise man's economic life. It promises to increase pro-

[1] Cf. Michael Fane in Compton Mackenzie's *Sinister Street*, I and II, *Guy and Pauline*, *Sylvia Scarlett*, *Sylvia and Michael*, etc.

[2] Cf. Drever, *The Psychology of Industry*, pp. 127–129.

duction without increasing effort and while decreasing discontent and unhappiness. By so doing it will promote welfare and enrich life not for any section of the people alone, but for the community in general.

Yet the benefits that Science can bestow upon Industry, so obvious to the onlooking philosopher, are apt to be suspected if not altogether denied by the working classes. Not without reason, perhaps, they fear their economic superiors, "even bringing gifts"; and they have not forgotten "the tragedy that seemed to set science in the lists against happiness and knowledge against freedom."[1] And just as the newly invented machines, doing in one hour work that formerly took ten hours, and giving to the educated observer visions of an Eldorado rich beyond the dreams of avarice, seemed to the Luddites of 1811 to threaten only economic enslavement, so the American Scientific Management Movement has aroused in the minds of many of the workers such grave distrust as to defeat its own ends. Nevertheless any attempt to estimate the economic importance of Industrial Psychology must include some reference

[1] J. L. Hammond, *The Skilled Labourer, 1760–1832*, p. 4.

to the pioneer work done by Frederick Winslow Taylor and his disciples and successors.

The term "Scientific Management" has been very prominent in the United States throughout the last dozen years,[1] and although the name is now disappearing, borne away on the tide of new names, new ideas, new movements with which America seems to be inundated every twenty years or so, the fundamental ideas of the movement live on and are to be traced in the activities of the "Efficiency Engineers," in the "Personel Administration" Movement, and even to some extent in such schemes of "Industrial Democracy" as Mr. Leitch outlines in his *Man to Man*.[2] These fundamental ideas are concerned with what may be termed the "administration" of factories as distinguished from the commercial policy and technology.[3] This is a matter which has been

[1] Sir Wm. Ashley, *Scientific Management and the Engineering Situation.*

[2] *Man to Man*, J. Leitch, Putnam, 1920. Although Mr. Leitch's methods are widely different from those of Mr. Taylor, the fundamental idea of eliminating the waste of misdirected human effort was suggested by the Taylorian experiments.

[3] *Sir Wm. Ashley*, op. cit., p. 7.

grossly neglected, especially in England, with the result that great and indefensible wastes of human effort occur. "Scientific Management" aims at preventing these wastes by getting "the right man to use the right tools in the right way"[1] under the best possible conditions. According to the principles laid down by the best exponents of Scientific Management, there are two distinct stages to be observed in the introduction of the new system; the first consists in reorganising the factory from the point of view of the material conditions; the second in changing the methods of work, the hours of labour and the distribution of work and rest periods, in trying to apply human effort with the same economy and scientific accuracy as we have been able to apply machine power.

It is in dealing with the problems presented by the reorganisation of the material factors that the Scientific Management movement has had its greatest successes. Its influence in this direction has been all for the good. It has insisted on the careful study of the organisation of the factory from the point of view of saving unnecessary expenditure of

[1] J. A. Hobson, *Work and Wealth*, 1914, p. 204.

human effort such as is incurred when, in the course of manufacture, an article is taken from end to end of a large factory several times to undergo different processes when it might have been arranged that the different machines should be placed in the order in which the processes had to be performed and one passage through the factory would have sufficed.[1] Great savings have been made by proper "routing"; by wise placing of store rooms, offices and machinery; by insisting on the use of the best machines and tools for every purpose; by the prevention of lost time in innumerable ways; and by the prompt adoption of labour-saving devices. The work of the Planning Department has been very valuable in this direction and an enormous advance on the old haphazard methods which held the field before. Great attention has been paid, too, to the discovery and application of the best processes, and the best ways of running the different machines. Taylor's work on the best methods of cutting metals[2]

[1] Cf. S. Webb, *The Works Manager of To-day*, p. 133, Sir Wm. Ashley, op. cit., p. 8, and *Notes on Commerce*, II, Taylor, *The Principles of Scientific Management*, which gives the "philosophy" of Scientific Management.

[2] Taylor, *Principles of Scientific Management*, p. 100.

produced highly beneficial results—the same machines directed by the same operatives but using the slide-rule, which enabled them to arrange the speed and feed of the machine to the best advantage for different metals, were able to produce from two-and-a-half to nine times the output without adding to the effort or the overhead expenses. The changes which were introduced in this first step towards Scientific Management were not by any means new—the only difference was the completeness and minuteness with which all the equipment of the factory was overhauled in order to get as far as was possible by such means the conditions of maximum efficiency for each worker.

The greatest difference between the older types of management and that introduced by Taylor was in the careful examination which was made of those factors which directly affect the efficiency of the "human machine" —the methods of work, the arrangement of tools and materials on the work bench, the height of the bench, the percentage of time "under load" and the distribution of natural rest pauses, the best possible combination for each kind of work of rest and activity, the

hours of labour, the system of payment, and the effects of changes in these variants on that efficiency. Looking at the work of Taylor, Gantt and Emerson in this direction in the light of the latest developments of psychological and physiological knowledge, it is fatally easy to underestimate the importance of the pioneers who called attention to the need for research into these matters if only by their mistakes in attempting to eradicate the evils consequent on past neglect. In so far as they insisted on the application of knowledge based on experiment to the determining of hours of labour, and showed the advantages to be gained by properly arranged intervals for rest and refreshment, they opened a new field for the investigations of psychology. In so far as they insisted on the evil effects of rate-cutting and showed that high wages do not of necessity mean high labour cost per unit of output, their influence was in the direction of a better understanding between employers and workers and the realisation of the fundamental necessity for friendly co-operation as the basis for real efficiency. And in so far as their minute study of each job, their analysis and synthesis,

their time and motion study, were carried out with the idea of avoiding waste and not of "speeding up" the workers, they were all to the good. Their insistence, too, on the principle of scientific selection of those workers whose ability and physique most fitted them for the job pointed out for investigation one of the greatest wastes of human effort, and although, as in many other points, too, their practice was not up to their theory, yet their title to fame must rest upon the principles they enunciated and the stimulus which they gave to truly scientific investigations into the most efficient way of applying human energy to industry rather than on the actual results which they achieved.

Having paid tribute to the value of the work of the pioneers of the "Scientific Management" Movement, we must consider their failures, so that from their errors we may gain at least a negative form of wisdom. With the exception of the Gilbreths, who seem to me to stand apart from the main group of American Scientific Management experts, the Taylorians were crude in method and "profoundly ignorant of the broader humanitarian and social problems which

Scientific Management creates and involves."[1] They had no understanding of "the aims, attitudes, problems, standards and ideals of the workers whose needs and welfare and sense of justice they easily assume to interpret and to be able to satisfy." Even in the United States, where industrial legislation, racial and linguistic differences and an entirely different and less complete set of traditions make Trade Unionism comparatively weak and enable the employer to try such experiments more freely than in this country, Scientific Management aroused the opposition of the workers. This opposition was so intense that it actually led in 1915 to an amendment to the Army Bill being accepted, stipulating that none of the moneys voted therein should be available for the salary of any time study expert nor for the payment of any bonus to an employee in addition to his regular salary.[2] This was the sequel to an investigation into a so-called Taylorian system introduced by General Crozier at the Watertown Arsenal during the period 1909–1911, and to a subsequent wider

[1] Hoxie, *Scientific Management and Labour*, p. 120.
[2] Muscio, *Lectures on Industrial Psychology*, p. 233.

investigation made by Professor Hoxie, Mr. Valentine, an employer's representative, and Mr. Frey, a representative of organised Labour. The report of this "Federal Commission on Industrial Relations"[1] seemed to show that while there are many sound principles advocated by the Scientific Management experts:

1. The practice of Scientific Management falls very far short of the principles, and in many respects fails entirely to substantiate its claims to be scientific.

2. Even if the theory were fully and properly applied it would inevitably result in a great loss of bargaining power by the workers, whose hostility is fully justified under a system under which the standard of living depends so largely on the relative bargaining power of workers and employers.

It is not necessary here to go into the details of Labour's case against Scientific Management as set out in this report. Our purpose will be served by quoting a few of the conclusions reached. "In practice scientific management must therefore be declared autocratic, in tendency a reversion to industrial autocracy . . . which forces the workers to depend on the employer's conception of fairness and limits the democratic safeguards of the workers."[2]

[1] Published as R. F. Hoxie's *Scientific Management and Labour*.

[2] Hoxie, op. cit., p. 112.

Furthermore, the intense specialisation of the workers and the gathering together of the craft knowledge which was once the monopoly of the craftsmen but becomes the monopoly of the employers " tends to break down existing standards and prevent the establishment of stable conditions of work and pay."[1] The general conclusions agreed upon by all three members of the Commission were as follows:[2]

" Two essential points stand forth. The first point is that Scientific Management, at its best and adequately applied, exemplifies one of the advanced stages of the industrial revolution which began with the invention and introduction of machinery. Because of its youth, and the necessary applications of its principles to a competitive state of industry, it is in many respects crude, many of its devices are contradictory of its announced principles, and it is inadequately scientific. Nevertheless it is to date the latest word in the sheer mechanics of production, and inherently in line with the march of events. . . ."

" The second point is that neither organised nor unorganised labour finds in Scientific Management any adequate protection to their standards of living, any progressive means for industrial education, or any opportunity for industrial democracy by which Labour may create for itself a progressively efficient share in efficient management. And, there-

[1] *Scientific Management and Labour*, p. 127.
[2] *Ibid.*, pp. 137–139.

fore, as unorganised Labour is totally unequipped to work for these human rights, it becomes doubly the duty of organised Labour to work unceasingly and unswervingly for them, and, if necessary, to combat an industrial development, which, not only does not contain conditions favourable to their growth, but, in many respects, is hostile soil."

In comparison with the position in the United States organised Labour in England is very strong. The principle of collective bargaining is accepted unquestioningly, even by employers themselves, and the adjustment of wages in this country is in the main industries settled by organisations working on this basis. This was the soil into which was cast the seed of a system avowedly hostile to collective bargaining.[1] Even if it had not been for the Hoxie report, which gave a very strong lead to British Trade Unionists on this matter, the attitude and style of Taylor would have aroused great hostility among them. Mr. Gilbreth, speaking of Taylor, is reported to have said, "Talk about anyone having a bump of tact—why, he hadn't so much as a pimple of it."[2] The account which he gives of his conversation

[1] Cf. Taylor, *Shop Management*, pp. 69, 183 and elsewhere.

[2] Gilbreth to Dr. Myers.

with Schmidt, "the little Pennsylvania Dutchman," is sufficient to bear out Gilbreth's statement. It is not, it seems to me, so much the principles underlying Scientific Management to which Labour is opposed, but rather the attitude of those who advocated it, and first installed it. The effect of such statements as "All employees should bear in mind that each shop exists first, last and all the time, for the purpose of paying dividends to its owners,"[1] and "By high wages he means wages which are high only with relation to the average of the class to which the man belongs and which are paid only to those who do much more or better work than the average of their class,"[2] is to cause Scientific Management to be associated very strongly with the worst elements of the system of industrial organisation which they detest. This is strengthened into a certainty that Scientific Management will end in "speeding up" and driving by the suggestion of Taylor that Schmidt was not doing a full day's work because he was able to trot home after his work and had actually sufficient energy left

[1] Taylor, *Shop Management*, p. 143.
[2] *Ibid.*, p. 27.

to be engaged in building himself a house in his spare time. Taylor would have a task set which would be a "big day's work"—"each man would be called upon to turn out the maximum amount of work a First Class man of his class can do and thrive," and the management is to be sole judge as to whether he is "thriving." The suggestion is that the workers are to devote their whole lives and energies to work—to live to work instead of working to live. Taylor's claim to be an impartial scientific investigator seems ludicrous when he says "it does not do for most men to get rich too fast,"[1] and again, "The exact percentage by which the wages must be increased in order to make them work to their maximum is not a subject to be theorised over, settled by Boards of Directors sitting in solemn conclave, nor voted upon by Labour Unions. It is a fact inherent in human nature,"[2] but persistently applies this to workmen and wages only. The impartial scientist would surely have investigated the effect of the rapid increase of riches which resulted from the application of "scientific"

[1] *Principles of Scientific Management*, p. 74.
[2] *Shop Management*, p. 25.

methods, on the shareholders who received so disproportionate a share of the savings, and would have found the exact percentage by which the dividends must be increased to obtain the necessary amounts of capital. Instead, we find him boasting that by introducing his plan he had increased the average daily output of men shovelling different materials from 16 to 59 tons a day, reduced the number of men required from about 500 to 140 and saved for the company between 75,000 and 80,000 dollars, which means that the extra profits to the company would equal the total wages bill for the year of the men on whose work the amount was saved.[1] There is small wonder, therefore, that "in Trade Union circles, Scientific Management as understood in the U.S.A. is looked upon with considerable suspicion, and in certain quarters a rather cynical attitude has been developed towards it."[2]

If we wish in England to apply the truly scientific knowledge of psychology and physiology, so wonderfully expanded and de-

[1] Cf. J. A. Hobson, *Work and Wealth*, p. 207.

[2] Letter received from Mr. F. Bramley, Assistant Secretary to the Trades Union Congress General Council.

veloped during the war period, to industry and commerce in order to eliminate the incalculable wastes of human effort which add so greatly to the "human costs"[1] of production, impoverish our people, and tend to prevent the development of a fuller, happier life, surely the ultimate aim of economic activities, we must avoid not merely the errors but the very suspicion of association with Scientific Management as understood in the U.S.A. An authority[2] has informed me that "there is, however, no prejudice in Trade Union circles against increasing industrial efficiency, providing no attempt is made to speed up the workers in the direction of sweating, or to treat them as machines in the way of using them as elements in production to be manipulated and dovetailed together regardless of human relationships." That humanism which is so marked a feature of the Labour movements throughout the world,[3] "while approving the application of

[1] For this use of "human costs," apart from economic costs, see J. A. Hobson's *Work and Wealth—a Human Valuation*, pp. 1–19 and 60–72.

[2] Mr. Fred Bramley, see footnote No. 2, p. 19.

[3] Cf. McKillop on Trade Unions, *Efficiency Methods*, pp. 159–186, N.B. p. 178.

science to the arts of production and consumption, insists that it shall be shown to be the servant, not the master, of humanity."[1]

The fundamental difference between Industrial Psychology and Scientific Management is the different attitude of the former towards the problems with which it deals. During the war period psychologists and physiologists were called in to help to obtain the maximum production of materials from the munition factories which could be maintained for months or even years. Throughout their investigations they showed themselves everywhere the friends of the workers, and to this, no doubt, owe much of their success.[2] Their work is being carried on to-day by the National Institute of Industrial Psychology, and with so much tact and real success that their investigators have in many cases received the spontaneous thanks of the workers involved.[3] This difference in attitude has been appreciated and expressed by many of the leading advocates of the application of

[1] J. A. Hobson, op. cit., p. 225.

[2] Cf. Reports of the Industrial Fatigue Research Board and of the Health of Munition Workers' Committee.

[3] Cf. Journals of the National Institute of Applied Psychology, e.g. pp. 61 and 169.

science to management in this country. Sir William Ashley[1] has shown that in important respects the teachings of Taylor are out of harmony with the best English traditions. Dr. Myers[2] repeatedly insists that where there is danger that the workers may be put in a position which is less easily defended from oppression or autocracy, or where they are subjected temporarily to the danger of unemployment through no fault of their own, extra safeguards must be given to them before any changes are made. In a paper which he read before the British Association[3] he pointed out these differences more particularly. He showed that the Industrial Psychologist "is diametrically opposed to Taylor's ideal" . . . that under present conditions "the managers assume . . . the burden of gathering together all the traditional knowledge which in the past has been possessed by the workmen";[4] that the "quest of the One Best Way" advocated by the Gilbreths was unscientific; that the Trade Unions of this country should

[1] *Scientific Management and the Engineering Situation.*

[2] *Mind and Work*, and in lectures and articles in the *N.I.I.P.J.*

[3] *N.I.I.P.J.*, pp. 168–172.

[4] Taylor, *The Principles of Scientific Management*, p. 36.

make it one of their functions to inquire into the best methods of work and of training; that the field of investigation to which the scientific manager was limited is too narrow, and the industrial psychologist may find it essential to extend the scope of his inquiry to include ethical and economical aspects of the operations he is studying; and that the mechanistic standpoint of the efficiency engineer who expected men to behave like machines, turning out a constant hourly output throughout the working day, showed gross ignorance of psychological and physiological facts.

The British attitude to the different features suggested by the "Scientific Management" school was ably expressed by Mr. E. Farmer in a paper read before the Physiological Section at the Edinburgh meeting of the British Association.[1] "We have three choices open to us:

1. Unreconcilable hostility to the study.
2. Approval of its present form.
3. Scientific inquiry into its possibilities.

The first attitude is one that can only be adopted by those who are adverse to any new

[1] *N.I.I.P.J.*, pp. 18–22.

development in industry; and the second can only be adopted by those who regard cheap production as of greater importance than human happiness and human health." The third method is the one which we must adopt in this paper, first of all taking each division of the subject and showing the discoveries which have been made and the particular economic results likely to follow their application to industry, and then estimating the changes which are likely to be produced in our economic organisation by the general application of all this knowledge of the psychological effects of industrial processes.

CHAPTER II

VOCATIONAL SELECTION AND GUIDANCE

FOR many years now educationists have been experimenting in the application of psychology to the problem of discovering and measuring mental capacity or "general intelligence." At first they made little progress and met with much hostility, but in recent years their successes have been so great and the acceptance of psychological tests as a measure of intelligence has become so general that it has become necessary for psychologists to warn enthusiastic educationists that as yet such tests are far from infallible and must not be used as the sole basis for important decisions.[1] Among the most valuable contributions to industrial progress made by the "Scientific Management" school in America was the emphasis which they put

[1] Cf. Crosby Chapman, "The Unreliability of the Difference between Intelligence Ratings and Educational Ratings," *Journal of Educational Psychology*, Feb., 1923.

upon the necessity for scientific selection of the most efficient workers for each kind of work. In the oft-quoted case of Pig Iron Handling at the Bethlehem Steel Works,[1] Taylor's first step was to select the right kind of worker, and although his insistence on employing only first-class men which necessitated the dismissal of seven out of eight of the men who had previously done the work would be impossible if scientific selection became general, the results of his experiment showed the gains in efficiency which such selection helped to make possible. From the scientific point of view the value of this experiment and the equally familiar one carried out by Thompson at a Bicycle Ball Factory[2] is seriously diminished by the introduction of several changes at the same time, so that it is impossible to judge how much of the saving in time and effort which resulted in this second case from shorter hours, the introduction of rest periods, better methods of work and selection of the workers who had a low reaction coefficient, was due to such selection

[1] Taylor, *Principles of Scientific Management*, pp. 58–64.

[2] Given by Taylor, *Principles of Scientific Management*, pp. 86–97.

and how much to the other changes. The investigation into the practice of "Scientific Management" shops carried out by Hoxie[1] showed that these did not justify the claims made—that workers were "scientifically" selected, and it has remained for the Industrial Psychologists to devise means whereby the enormous waste of efficiency which results from wrong choice of occupation and the employment of workers who might be highly efficient at some other work in an occupation for which they are not fitted[2] may be avoided. The extent of such waste at present is far greater than is popularly imagined. It has been estimated that in the United States alone "it would be possible to increase the national wealth by $70,000,000,000 each year by properly fitting every man, woman and child to the kind of work each could best perform."[3] Instead of attempting to do this, however, at present boys and girls are guided in their choice of a profession by untrustworthy advertisements, by suggestion, imita-

[1] Hoxie, *Scientific Management and Labour.*

[2] "That excellence of work intimately and inevitably depends on the well-being, interest and suitability of the worker is now generally recognised," p. 1, *N.I.I.P.J.*

[3] *New York Times*, quoted, p. 76, *N.I.I.P.J.*

tion, desire for immediate material gain, or purely accidental circumstances,[1] taking the first opening which presents itself, and the boy who might have been a highly efficient engineer becomes an unsatisfactory and dissatisfied clerk, while the boy who might have become an efficient clerk and done the work in half the time is condemned by chance to waste his talent as a plumber's apprentice.[2] Moreover, it has been found that "in so far as a man does work for which he is naturally most fit, he works easily and with relatively little fatigue, since he moves along the lines of least resistance,"[3] and on the elimination of unnecessary fatigue depends the future of industry.[4] The enormous waste of the present chaotic selection of workers lies in its disregard for individual differences. "For each individual," Dr. Myers has said, "there is one occupation more suitable than any other, and in every occupation some succeed better than others owing to wide mental and physical

[1] Cf. *N.I.I.P.J.*, p. 29.

[2] Cf. Muscio, *Lectures on Industrial Psychology*, p. 105.

[3] Muscio, *Lectures on Industrial Psychology*, p. 107, and also *I.F.R.B.*, X, quoted Chapter III.

[4] Cf. Chapter III, also Stanley Kent, "Industrial Fatigue," p. 187, *Industrial Administration*.

differences."[1] It has been found that tests for speed in feeding machines correlate highly and positively with known fitness of the subjects for a slow-running or a fast-running machine in the factory, and that a worker who is below the average on a slow-running machine may be considerably above the average on a fast-running machine.[2] The economy which would result from finding for which type of machines a worker was fitted and employing him on that type is obvious. In the course of an investigation into the Tin Box Industry undertaken on behalf of the National Institute of Industrial Psychology[3] it was found that workers engaged in soldering boxes, some of which were round and others angular in form, found greater difficulty in one type of work than in the other, and the data obtained proved that some found greater difficulty in doing one type and others in doing the other type. By arranging that those workers who naturally moved their hands more easily in circles should be employed on round tins, and those who found it easier to move along straight

[1] Myers, *Mind and Work*, p. 85. [2] Myers, op. cit., p. 92.
[3] "An Investigation into the Tin Box Industry," E. Farmer and R. St. C. Brooke, *N.I.I.P.J.*, p. 11.

lines should be employed on angular tins, much unnecessary fatigue was eliminated and greater satisfaction was obtained from their work. Another way in which vocational selection can eliminate waste is by lessening the avoidable labour turnover. Dr. Myers has estimated that in the case of factories where women are employed the rate of labour turnover is usually from 50 per cent to 300 per cent[1]—that is to say, in order to keep a staff of 100 workers, from 50 to 300 workers have to be engaged each year. A high rate of labour turnover is due largely to unsatisfactory conditions and unsuitability of workers.

A recent inquiry into the loss which is occasioned by labour turnover[2] has shown that, while in the case investigated, the average length of stay of workers leaving within two years was 14¾ weeks (and this average was high because of a number of workers who stayed twenty-six weeks), the average daily output of workers increased steadily up to the twentieth week after they were engaged and afterwards remained approximately level.

[1] Dr. Myers, *Mind and Work*, p. 85.

[2] "An Inquiry into Labour Turnover," *N.I.I.P.J.*, pp. 103–107.

The loss in potential output owing to workers leaving and new workers having to be engaged was 26,520 units—equivalent to an output of approximately eleven days' work from each of the workers who left. To this direct loss can be added the indirect losses which are due to the increased amount of work spoilt by new workers; the time wasted by the foreman in interviewing new-comers and supervising their work; the unsettling of the department by the constant coming and going of new workers, which seems to encourage others to leave; the impossibility of developing that esprit de corps which is so important in the administration of a factory; the difficulty in getting new workers when once a works gets the name for not keeping its workers long and the extra clerical work which is involved in taking on new workers and entering up their records. The investigator's conclusions were that "considerable improvement could be effected if more careful inquiries were made before engaging new hands; a proper system of vocational guidance would help in this respect,"[1] but there was also need for changes in the conditions of work.[2]

[1] *N.I.I.P.J.*, p. 107. [2] Cf. Chapter IV.

The Committee on the Elimination of Waste in Industry of the Federated American Engineers Society in their report draw attention to the bad effects on output which follow the worry and uncertainty of employment in such trades as the building trade in which, it is reported, one worker worked for seventy-six different contractors and was hired 108 times in the course of five and a half years. They also give an expert's estimate of the average annual waste in the metal industry alone, due to avoidable labour turnover as $100,000,000.[1] Dr. Myers has suggested that the wrong choice of occupation is at the root of a great amount of present-day misery and that this is one of the factors in the production of industrial unrest. To this great accumulation of waste, due entirely or in part to lack of vocational guidance and selection, must be added the waste due to accidents resulting from unsuitability and from the high rate of labour turnover which is in part due to the unsuitability of the workers engaged in an industry. Drever has drawn attention to the fact that not only profits and the worker's happiness depend

[1] "Waste in Industry," by the Committee on Elimination of Waste, etc., quoted *N.I.I.P.J.*, p. 206.

upon the selection of the right grade man for each job, but also the lives of fellow-workers in many cases.[1] Dr. Vernon gives striking confirmation of this statement.[2] "In one trade," he says, "on an average accidents were five times more numerous during the first day's work than in the next five days, and subsequently they dwindled so rapidly that in the last six months of the year they were 255 times less frequent than they had been on the first day." An American investigation showed that 67·95 per cent of those leaving during the year left during the first three months of employment,[3] so that the probability of accidents was far higher than it would have been had the labour turnover been less high and the length of service longer. The present method of chance selection is shown, therefore, to be a source of inefficiency and a cause of waste of material goods, human energy and even human life.[4]

[1] Drever, *The Psychology of Industry*, p. 23.

[2] Dr. Vernon, "Industrial Fatigue and Efficiency," quoted *N.I.I.P.J.*, p. 45.

[3] *U.S. Public Health Bulletin*, cvi. quoted *N.I.I.P.J.*, p. 202, cf. *I.F.R.B.*, xiii, p. 29.

[4] Further confirmation of Dr. Vernon's statement is given in the account of an investigation into the number of breakages in the catering trade. Many instances occurred

The problems which are presented to the Industrial Psychologist in seeking to apply his science to Vocational Selection can best be considered in two classes :

(*a*) Those which are related to the question of selecting from a number of applicants, who claim to be trained, those most suited for the particular job.

(*b*) Those related to the question of testing the initial capacity of untrained individuals, so as to select those most fitted for training in a particular industry, or branch of an industry.

In the case of group (*a*) it is necessary to find :

i. The " general intelligence."
ii. The physical capacities.
iii. The special capacities for the particular job of the applicant.

i. It is in the measurement of general intelligence that psychology has been most widely tried and has met with the greatest measure of success. For some work it is the predominant factor, and general intelligence tests alone may be adequate. In educational work the Binet-Simon scale, the Yerkes-

where the introduction of a new worker immediately doubled or trebled the breakage at certain points. Cf. p. 140, *N.I.I.P.J.*

Bridges point scale and the Stanford revision of the Binet-Simon scale have met with considerable success, and Drever has found that for a preliminary examination of children six tests from the Stanford revision give excellent results which can be obtained quickly and easily.[1] Examples of such tests will be given later. For industrial purposes, for the purpose of testing applicants for a post, the type of tests which were employed with considerable success by the United States Army for grading recruits and selecting men for special services is of most use. The tests employed for this purpose were eight in number and consisted of:

i. A Directions Test. The subject is given a paper on which are printed several rows of figures and letters. The examiner give certain instructions which must be carried out in a limited time, and the score depends on the accuracy and speed with which this is done.

ii. An Arithmetical Problems Test, consisting of simple problems to be answered in a given time.

iii. A Practical Judgment Test. A series of simple problems are set, and the subject must mark with a cross the correct answer from three different solutions suggested.

[1] Cf. Drever, *The Psychology of Industry*, pp. 11–24.

iv. A Synonym-Antonym Test. Two words are given which have either the same or an opposite meaning, and the subject must mark with an S or a D, according as the words have the same or a different meaning.

v. A Disarranged Sentence Test. The examinee has to rearrange the sentence and say whether it is true or false.

vi. A Number Series Completion Test which involves the carrying on for two more terms of a number series.

vii. An Analogies Test. Two words are given which bear a certain relationship. A third word is then given to which the examinee must add a word bearing the same relationship to the third word as the second bears to the first.

viii. A General Information Test.

Recruits were graded according to their success in these tests into classes A, B, C+, C, C−, D, D− and E. Grade A men were fit for commissioned rank, B for non-commissioned officers, Grade C+ for certain special services, Grade C for ordinary service, Grade D for services requiring little intelligence, and Grade E were rejected as unfit for service. In this way the waste of talent which was notorious in the British Army, where dentists were digging trenches and picking up waste paper while the efficiency of the fighting men

suffered from lack of their trained attention, was avoided.

ii. A careful physiological examination will give the necessary information with regard to the physical capacities of the applicant. In many cases these will be of great importance —for example, it is most unwise to select a man with a weak heart for the work of a dock labourer or a coal porter. The height, bearing, strength, acuity of vision, hearing and touch will be of varying importance according to the demands of the work to be done. An investigation was made for the Industrial Fatigue Research Board[1] into the effect of physical type upon efficiency in chocolate packers, chocolate wrappers and chocolate dippers. Measurements were made of the span of the fingers, their length and breadth, the length, breadth and thickness of the hand, length and other arm and forearm measurements. The conclusion reached was that, although physical type plays little part during the early period of a young factory worker's life, when settled down " the innate physical qualities which make for proficiency make themselves very clearly felt."

[1] *I.F.R.B. Report*, xvi, pp. 85 and 86.

iii. In many occupations, besides a varying amount of intelligence and physical strength, certain special qualities are necessary. In some occupations the special qualities are of paramount importance, and tests which discover and measure them correlate very highly and positively with skill in the occupation. Wherever such special capacities are essential it is necessary that tests should be devised to discover and measure them. It has at times been suggested that just as "general intelligence" can be measured by a simple scale of tests, so also a scale could be devised to measure general "motor capacity"—to find if the applicant is of predominantly "motor" or "mental" type—if such types exist. A most important investigation into the question of "motor capacity" was carried out for the Industrial Fatigue Research Board by B. Muscio.[1] The object of the investigation was to discover if it were possible to devise tests to show suitability for those occupations in which intelligence counts for little, the principal activity consisting in the re-

[1] B. Muscio, "Motor Capacity with special reference to Vocational Guidance," *British Journal of Psychology*, Oct., 1922, pp. 157–184.

peated performance of some simple movements or cycle of movements, i.e. the emphasis is on motor, not on mental capacity. The result of the inquiry was the discovery that :

(*a*) There is no "motor type"—an individual may have motor capacities, but performance in one such activity is no indication at all of performance in another.

(*b*) Motor capacities are relatively independent of intelligence, as intelligence tests tend to correlate highly and positively, whereas motor tests show no correlation with one another, and so cannot correlate with a common standard.

(*c*) Therefore, every occupation involving the routine performance of specific movements will require specific vocational tests—to test just those motor capacities which function in that occupation.

In selecting workers for a particular job it will be necessary to find by analysis what special capacities—mental or motor—are required and then to devise tests to discover and measure such capacities, or else to devise complete tests which shall reproduce the essential processes of the work and test for the group of essential qualities together. A number of recent examples of the application of these rival methods of analysis and synthesis will be useful here to show the method of con-

struction, trying out, application and standardisation of scales of tests and the results which may be obtained.

An example of the method of analysis of the demands of the occupation and tests to measure the special capacities required is given in the report of an investigation in the printing trade carried out for the Industrial Fatigue Research Board.[1] The work of a hand compositor was found to demand:

(*a*) Good eyesight.
(*b*) Above-average physical strength.
(*c*) Right-hand and arm dexterity.
(*d*) Speed of visual observation.
(*e*) A wide immediate word-memory span, i.e. the ability to carry in the mind a large number of words immediately after they have been read.
(*f*) A fair degree of "general intelligence" and probably
(*g*) The capacity to estimate form and size.

The following tests were devised to measure these different capacities:

(*c*) The match-stick insertion test, which consists in inserting into a series of holes as many matches as possible in a given time.
(*d*) A cancellation test which consists in crossing

[1] *I.F.R.B. Report*, xvi, pp. 32, 33, 34. Abstracted *N.I.I.P.J.*, p. 114.

out every "e" in a page of senseless French as quickly as possible.

(*e*) A substitution test consisting in substituting a certain digit for each letter of a printed series.

(*f*) A directions test.

(*g*) A form-board test in which the subject fits a number of wooden pieces cut from a board into the spaces from which they were cut.

Two lists were prepared, one giving the ranking of the compositors according to success in tests C, D and E, the other their ranking by the overseers according to efficiency in composing. The coefficient of correlation between the two rankings was +·71 in one works and +·80 at another. (If the two rankings had corresponded exactly the coefficient would have been plus 1; if there had been no correspondence 0, and if an exactly inverse correspondence, −1.) The other tests did not correlate so highly and were left out of account until further investigations could be made. Tests for speed of observation, immediate memory span and intelligence were given to readers and the results correlated +·71 with efficiency in reading. Tests for "finger co-ordination" were added to the above tests and tried out on Monotype keyboard operators. The results

were astonishing, the average correlation of the ranking of the test results with the overseer's grading for efficiency being +·90—practically identical. The tests used in this last instance could be standardised and used for selective purposes with very good results.

Another example of the analytical method is given by Drever[1] with a description of the different steps necessary to the development of a scale accurate and delicate enough for practical use in the selection of typists. Tests were selected which seemed to involve the same mental and motor processes as the actual work:

(*a*) A substitution test such as has already been mentioned.

(*b*) A cancellation test as described.

(*c*) A memory span test to find how many digits or syllables the applicant could keep in mind after one exposure.

(This capacity, which is of great value in work such as typing, hand-composing, telephone operating (auditory memory span), etc., is found to differ greatly with different persons. Muscio found one subject who was able to remember forty-four numerals after having seen them exposed for about

[1] Drever, op. cit., pp. 29–33.

one second, while in some cases four numerals only can be remembered.) [1]

(*d*) An interference test which consists in naming rows of colours which are passed rapidly across the field of vision.

(*e*) Reaction time measured by special instruments in the laboratory is a factor of great importance in some kinds of work. For example, it was found that slow reaction, and a tendency to wrong reaction, were incompatible with success as a fighting airman, and many lives were saved by refusing to accept such men for the Air Force. The test consists in pressing a button which releases a shutter and discloses a coloured slide. The time between pressing the first button and selecting a key of the colour shown on the slide and pressing it is the reaction time. In this set of tests simple reaction time was taken—the time between receiving a signal and pressing a key.

(*f*) An Association test, in which the subject is given a word denoting a certain action, and must reply with a word denoting the corresponding agent.

(*g*) A further association test, a verb being given and its object demanded.

These tests were then tried on twenty typists whose skill at their work was known, and a graded score was given to show degrees of success in each test. The ranking in each

[1] Muscio, *Lectures on Industrial Psychology*, p. 94.

test was then correlated with the known ability of the typists. In every case positive correlation was found, the coefficients for the different tests being as follows :[1]

Test.	Correlation with Typewriting Efficiency.
Cancellation	·52
Substitution	·96
Memory Span	·52
Interference	·40
Reaction Time	·25
Association (Action Agent)	·43
Association (Verb Object)	·55

Reaction time is shown to be of comparatively little importance in typing, and would be left out of the standardised scale of tests. The other tests show fairly high degrees of correlation—sufficient to give a good indication of ability in a trained typist, although it must be remembered that these tests might not be satisfactory in testing for typing ability in embryo.

The value of vocational selection and the success of the analytical method has been demonstrated in the case of telephone operators. It was found that many operators failed in the work either in the six months'

[1] Quoted from Drever, op. cit., p. 32.

course of training which they received,[1] or later through nervous breakdown and ill-health.[2] The telephone companies lost heavily owing to the waste of training operators who were not suited to the work, and in different parts of the world — the United States, Australia and Germany—experiments were carried out which have resulted in a great saving. The capacities needed for the work are special and precise and include acuity of hearing and sight, clear speech, memory for numbers and for the order of instructions, visual and motor memory and capacity to interpret badly pronounced words. Münsterburg devised a series of tests which were applied to certain employees of a large telephone company who were in process of training. The results of the test were correlated with the success of the trainees as estimated by the supervisor. The results correlated very highly with the supervisor's estimate ; a number of skilled operators who had been included without Münsterburg's knowledge were placed at the top of the list,

[1] Münsterburg, *Psychology and Industrial Efficiency*, p. 101.

[2] Cf. Muscio, op. cit., pp. 124–131.

and those who were rejected as unfit for the work by the supervisor were at the bottom of the list. By a series of tests occupying about two hours it had been possible to find the comparative ability of the applicants for the position of telephone operator as accurately as by a six months' course of training and with far less expense. The workers were spared the waste of time and the discouragement consequent on failure.[1]

As industrial processes become more and more specialised, the importance of individual differences becomes greater and the possibilities of increased efficiency by the selection of those workers who have the special capacities required by the work—often very narrowly limited and easily overlooked—are increased enormously.

In illustration of the synthetical method of procedure, which avoids the sometimes difficult process of analysing the capacities needed for a particular task, we may take the very thorough tests for clerical occupations devised by Cyril Burt[2] and the well-known test

[1] Quoted by Drever, Myers and others. Given here from notes on a lecture given by Dr. Myers at Birmingham, March 15, 1923.

[2] *N.I.I.P.J.*, pp. 23–27 and pp. 79–81.

for car-drivers used by Münsterburg.[1] The tests for clerical occupations test special abilities by the actual work of typing and shorthand-writing, while the test for car-drivers presents a situation so like that presented by the actual work that the drivers on whom the tests were "tried out" said they experienced the same feelings while undergoing the test as when they were actually at work.

In the tests for clerical occupations great care was taken in selecting those tests which would detect and measure the essential qualities of a successful shorthand-typist. The tests were first "tried out" on a body of highly skilled and intelligent typists and were amended and improved, unsatisfactory tests being eliminated. They were then applied to one hundred intelligent children, and their effectiveness was verified by correlation with an independent grading for intelligence. Finally, the rearranged tests were applied to all the available typists in the office of a large Education Authority—some thirty in number—who were graded by the

[1] Quoted Drever, op. cit., pp. 36 and 37. Muscio, op. cit., pp. 133–141.

supervisor according to efficiency in general office work, in typewriting and in shorthand-writing. The ranking according to success in the tests was then correlated with the ranking according to efficiency. The tests applied included tests of General Intelligence, of Educational Attainments, of Linguistic Ability and of General Information, and special tests for speed and accuracy in shorthand and for speed when typing from memory and when typing from copy, for accuracy, display and tabulating, and for manuscript reading. Except in the case of the typewriting tests the tests were applied to groups, the shortage of machines and other difficulties made it impossible to give the typewriting tests as group tests. They were given on a typewriter of a make which was unfamiliar to all the subjects. The results were very satisfactory: the coefficients of correlation obtained were sufficiently high to justify the use of the tests for selecting applicants for posts as shorthand-typists. General Office Efficiency correlated especially highly with the order for General Intelligence; the coefficient was +·79. The special tests correlated highly with the supervisor's order for efficiency in shorthand-

writing, +·79, and in typing +·60. Allowing for the difficulties involved in applying the tests for typing—the subjects being tested at different times of the day and on a machine which may have been stranger to some than to others—the results are highly satisfactory. Data has since been obtained from other groups which confirms the investigator's conclusions, and a scale of tests has now been standardised and is being applied for the practical purposes of selecting suitable workers from applicants for posts.

Münsterburg's test for car-drivers was devised at the request of several great companies who were dissatisfied with the great waste involved in the indemnities which they had to pay to sufferers in accidents and which was calculated in some cases to amount to 13 per cent of the gross takings of the company. It was found that the accidents were not entirely due to fatigue, but to the mental constitution of the motor-men. One of the most important capacities needed was attention of a special kind. Attention may be of two kinds—spread or concentrated. Although they may not exist separately, these different types of interest certainly occur in different propor-

tions.[1] In this case attention of the concentrated type might be dangerous, for it is necessary for the driver to note many different factors in different parts of his field of vision. Widespread attention, foresight and imagination are necessary to success, and speed must be combined with safety. The test which was devised consisted of a series of twelve cards, each of which was divided into squares—nine across, twenty-six in length. Down the centre of the card ran lines representing rails, and in the squares were figures marked in red and black ink. The black figures represented vehicles and pedestrians moving parallel to the rails; red figures represented motor-cars, horse-drawn vehicles and pedestrians moving at different given speeds across the rails, so that it was possible to tell those that would be on the rails when the car reached that spot. Each square between the rails was lettered so that as each danger-point was noted it could be pointed out by calling out the letter. These cards were placed under a moving velvet band, the speed of which was controlled by the examinee, and which was cut so as to

[1] Cf. T. H. Pear, "The Application of Psychology to Industry," *Industrial Administration*, pp. 37–38.

allow the operator to see five squares ahead as it moved. After the test had been carefully explained to them, experienced drivers of known degrees of skill were tested and marks were given according to the speed and the accuracy with which the test was carried out, each omission of a danger-point being counted as equivalent to ten seconds' extra time added to the time taken. It was found that the ranking according to success in the test corresponded very closely with efficiency in actual service. Such a test, which could be applied in ten minutes, would enable a great saving by preventing many accidents and avoiding the waste of time and money involved in training men who are later found to be useless; it has been estimated that 25 per cent of the applicants would be rejected—men who might do well in other occupations but who would waste their time and energy in this one.

Despite the results which have already been achieved by these tests of both types it must be remembered that they are not by any means perfect or infallible. One of their gravest deficiencies at present is that they do not give sufficient indication of industry,

conscientiousness, temperament, will and other character qualities which greatly affect efficiency and success in almost any occupation.[1] It follows, therefore, that they must not be relied on as the sole basis for a decision as to which of a number of applicants is most suited for a post, although they can indicate those who are not so well trained, or so well fitted as others. They must be applied in conjunction with school records, and all information which can be obtained of educational, medical and physiological factors and of social, moral and psychological qualities, such as honesty, courage, loyalty, patience, politeness, punctuality, imagination, emotionality and self-control.[2] Tests are now being devised which will discover and measure these qualities, too. At the International Conference on Vocational Guidance,[3] at Barcelona, experiments were reported which show that changes in blood-pressure may indicate the temperamental and emotional characteristics

[1] Cf. Cyril Burt, op. cit., *N.I.I.P.J.*, p. 80, and " Report of the Berlin Conference on Applied Psychology," *N.I.I.P.J.*, p. 190.

[2] Cf. *Archives de Psychologie*, 1918, xviii, and abstracted *N.I.I.P.J.*, p. 116, and cf. also Myers, op. cit., p. 96.

[3] *N.I.I.P.J.*, p. 15.

of a subject. Dr. Myers says that "in point of fact, however, several of these qualities are revealed by many existing tests or by others that can be devised for the purpose, whilst full light can readily be thrown on the rest in the course of individual examination and cross-questioning." "None but those who have had experience in psychological tests can realise what a wealth of information in regard to the general 'character' of a subject is incidentally gained from a few tests systematically applied during an interview."[1] Another drawback in the use of these tests for vocational selection is the fact that, even though they may accurately measure immediate ability, they do not show capacity to improve with practice,[2] and they do not take into account the effect of test conditions on different people, the difference in the time needed by different people for "warming up" and temporary emotional and physical conditions which may affect the test results. This difficulty is fully recognised, but it is hoped that by carefully following up the results of selection by tests and by continued

[1] Myers, op. cit., p. 96.
[2] Muscio, op. cit., p. 144.

research it can be greatly modified if not eliminated. In any case there can be little doubt that selection based on scientific tests such as have been described will be far more reliable than the present method of selection by general impression, personal judgment and other entirely subjective methods, or the expensive method of "trial and error." Apart from the economic pressure which will be brought to bear upon employers by the great extension of scientific vocational selection abroad, the inducement which it offers in the way of increased profits is sure to win the favour of employers and managers[1] and encourage them to call in the expert psychologist just as they now call in the consultative engineer. Difficulties may be met with if care is not taken from the side of the employees and the foremen. The foreman will lose some of the authority and power which the taking on of workmen, not entirely free from jobbery at times, it is to be feared, has given him. There is a tendency for the workers to suspect

[1] Drever, op. cit., p. 41, "Accumulating evidence can easily be brought forward to show the great increase in output, and diminution in expenses that have followed upon systematic vocational testing, and placement in individual instances where tests have been applied."

vocational selection as an instrument merely for increasing the employer's profits. This is not always the case, as is shown by the fact that the Berlin Trade Unions annually vote a contribution to the Psycho-technical Institute attached to the nearby Technical High School.[1] Moreover, it is obvious that the workers suffer most from wrong selection—their happiness and success throughout life depend on their fitness for their job—and also they bear the risks due to the presence of misfits among them.[2] The difficulty will be entirely avoided if the suggestions of Dr. Myers are carried out:

i. Vocational tests shall not be forced upon an employee once he has been engaged.

ii. The workers shall be guaranteed against unemployment through no fault of their own.[3]

iii. The workers shall be given some voice in the management which would include some control over the expert applying the tests.[4]

Up to the present we have dealt chiefly with the tests necessary for the selection of the best

[1] Miles, "International Conference on Vocational Guidance," *N.I.I.P.J.*, p. 17.

[2] Recently an inquiry into an accident to a boiler repairer whose eye was destroyed, discovered the cause to be the unfitness of the man's mate.

[3] Cf. Myers, op. cit., p. 105.

[4] Cf. *The Suggestion for Joint Control of Time and Motion Study Experts*, Chapter IV.

fitted from among the trained applicants for a position, but we have also to consider the wider problem of Vocational Guidance, case (*b*) the selection of the right occupation for the untrained young person to take up. Tests for this purpose cannot be so accurate as those for the selection of a suitable worker for a special job: it is easier to find which applicant has certain qualities than to find what are the best capacities of an individual and for what position they are most fitting. Besides information as to the physical, psychological and moral qualities necessary to selection in case (*a*) there is need for information on further points:[1]

i. General information concerning different occupations—a description of the work, the advantages and disadvantages, the preparation needed and the prospects offered. In this connection, tours of different kinds of factories should be made by children before they leave school, so that they may know something of the conditions of work in different industries before they decide which they would like to enter. In this way the child will get a broader outlook on social and occupational matters, and will have a greater opportunity to select some occupation which appeals to his interests. Interest is

[1] Cf. Articles by G. H. Miles on "Vocational Guidance in Foreign Countries," *N.I.I.P.J.*, Nos. 1, 3 and 4.

an important factor in success, although, unfortunately, "interest in an occupation and capacity to do well at it may not be conjoined." [1]

ii. Information is needed as to the probable demand for workers in the different industries as suggested by a forecast of the future possibilities of an industry—whether it is a rising one or a dying one.

iii. Information concerning the mental and physical characteristics of the best workers in the various branches of industry as shown by such tests as were described under (*a*).

iv. Information as to the mental and physical characteristics of the individual as shown by psychological, physiological and educational tests, school records, etc.

v. A classification of all the information regarding industries which require similar physiological and psychological capacities, so that the adviser can select for each individual a number of occupations for which his predominant capacities fit him.

The National Institute of Industrial Psychology is making investigations in England into the occupations which children and young persons most commonly enter, the best tests for the capacities necessary for these occupations and the psychological classes into which such tests can be grouped.[2] In the study of

[1] Miles, *N.I.I.P.J.*, No. 3, p. 108.

[2] Cf. *N.I.I.P.J.*, No. 5, p. 166, and Dr. Myers' speech at the Mansion House Meeting, *N.I.I.P.J.*, No. 2, p. 61.

vocational guidance and of vocational selection Great Britain is very backward. In most European countries—especially Germany, Belgium and Spain—in America and in Japan, numerous institutes and departments are busy developing methods of vocational selection and guidance. Among the most advanced and most successful of these are the several institutes in and near Berlin, which are regularly consulted by the great firms such as the A.E.G.,[1] Osram, the Berlin Tramways, etc.; the Institut d'Orientacio Professional of Barcelona with its four departments—(*a*) the Medico-anthropometric department, (*b*) the Psychometric department, (*c*) the Statistical and (*d*) the Information department, through which over a thousand children have passed, three hundred of whom are being closely watched so that any errors in guidance may be detected; and L'Office Intercommunal pour l'Orientation Professionelle et le Placement des Jeunes Gens et des Jeunes Filles dans l'Agglomeration Bruxelloise, which is supported from the rates and has branch bureaux in the different communes.

As a result of the activities of the institutes

[1] Allegemeine Electricitat Gesellschaft.

near Berlin tests have been devised from which considerable information as to a candidate's abilities is obtainable from which a very useful forecast of his suitability for engineering work can be prepared.[1] One of the great firms which has availed itself of their services—the great Berlin Tramways[2] (Grosse Berliner Strassenbahn)—is able to report that the saving resulting from scientific vocational selection and other changes based on psychological investigations amounted in 1922 to over 12,000,000 marks, or approximately £20,000 at that time. As a result of careful selection of postal and railway workers "a very considerable improvement, both in quality and amount of work, has followed. At the Post Office only 23 per cent of the candidates were found fitted for the work, but of these 96 per cent were thoroughly satisfactory."[3] On the railways less than 6 per cent of the selected pupils had unsatisfactory records, while 66 per cent of them were "very good." Moreover, vocational selection has resulted in a very much better type of ac-

[1] Miles, op. cit., *N.I.I.P.J.*, p. 17.
[2] *N.I.I.P.J.*, p. 111.
[3] *N.I.I.P.J.*, p. 190.

cepted workers. In Barcelona an investigation was carried out which showed that of 500 apprentices only 47 per cent chose their work for professional reasons—talent, interest, etc.; while 53 per cent were influenced by family, imitation, accidental circumstances, etc. The former proved by far the best workers and students.[1]

Although this movement is but in its infancy excellent results have already been obtained, and in the United States, Barcelona, Brussels and Germany much has been done towards "abolishing the huge number of occupational misfits and thus reducing not only the vast expense of a needlessly large labour turnover, but also the overstrain and unhappiness of the worker who has drifted into a wrong occupation."[2] Dr. Myers added that he believes that Germany "hopes to secure the lead in commerce and industry by paying attention to the human aspect, just as in pre-war days she advanced by paying attention to the material aspect; and her Trade Unions are recognising the value of

[1] Anals de l'Institut d'Orientacio Professional 3, Barcelona, *N.I.I.P.J.*, p. 208.

[2] Myers, at the Mansion House Meeting, *N.I.I.P.J.*, p. 61.

vocational guidance and of systematic training in approved methods of work."[1]

Taylor pointed out that while we had become aware of the enormous wastes of our material resources we were still ignorant of the even greater wastes due to the misdirected energy of human beings because that needed a little imagination to perceive. Those peoples who first realise how great that waste is and how much can be prevented by vocational selection and guidance, among the other applications of psychology to industry, will forge ahead just as surely as did those who first realised the possibilities of developing their material resources. One of the main economic results of the application of psychology to industry would be the preservation and fuller development of the country's greatest asset—the skill, genius and energy of her people.

[1] Cf. Chapter IV, *Approved Methods of Work.*

CHAPTER III

FATIGUE

" The hope of industry in the future lies in a right understanding of the nature, the causes, the results and the prevention of industrial fatigue."

A. F. Stanley Kent.[1]

" The problem of scientific industrial management, dealing as it must with the " human machine," is fundamentally a problem in industrial fatigue."

Health of Munition Workers Committee.[2]

SUCH evidence from Dr. Stanley Kent and from an important committee of experts must convince us of the need for careful study of the results of activity on the " human machine." We must be careful, however, to guard against the danger of allowing the metaphor " the human machine "

[1] A. F. Stanley Kent, M.A., D.Sc., " Industrial Fatigue " in *Industrial Administration*, p. 187.

[2] *Industrial Efficiency and Fatigue*, p. 9, Report of the Health of Munition Workers Committee.

to mislead us as it did the earlier Scientific Management experts of the U.S.A., who were primarily mechanical engineers, into attempting to treat the human organism as if it were mechanical. We must therefore begin our investigation with an outline, as far as possible in non-technical language, of the discoveries of physiologists and psychologists on the nature, causes and effects of fatigue; followed by an inquiry into the immediate and important results which the application of such knowledge to industry and commerce would produce.

Most definitions of the state, or process, of fatigue agree that it is marked by a diminution in the capacity for work and by subjective feelings which are often accompanied by a disinclination for work and a desire for rest.[1] But all such definitions require so many modifications that an account of the physiological causes and processes is essential to their complete understanding.

[1] Cf. Drever, op. cit., p. 61. Rivers, "a condition of lowering capacity for work which follows or occurs during the performance of work, and of which it is the direct result." Quoted, T. H. Pear, *Industrial Administration*, p. 72, also cf. Stanley Kent, op. cit., p. 187, and *Industrial Efficiency and Fatigue*, p. 8.

Activity of the human organism is the result of impulses initiated and sent out by the complex nervous mechanism of the brain and spinal cord and conducted by nerve fibres to the muscles, where the contractions which constitute the activity are produced by the breaking down of energy-producing materials stored in the muscles and replenished by the blood stream.[1] The energy-producing materials, which may be likened to fuel, are used and poisonous waste products produced (carbonic acid, lactic acid, etc.) which are normally carried away directly by the blood stream or indirectly by chemical processes which it induces in the tissue itself. The processes of destruction and construction are concomitant,[2] and fatigue results only when the rate of the destructive process is faster than that of the process of recovery. When this occurs fatigue is produced, not as is popularly supposed by the exhaustion of the stock of energy-producing material, but by the poisonous action of the waste products which are produced more rapidly than they

[1] Cf. *Industrial Fatigue and Efficiency*, pp. 8–9.

[2] Cf. *Industrial Fatigue by Physiological Methods*, Stanley Kent, p. 22.

can be carried away by the blood stream and eliminated.[1] Local fatigue is caused by the clogging of a particular set of muscles ; central fatigue is produced by the action of the poisons produced on the central nervous system and on other parts of the body to which they are carried by the blood stream. If an isolated muscle, apparently completely exhausted, is washed with salt water, so that these waste products are removed, new contractions will take place, with an impulse which before had proved insufficient.[2] The poisoning of the whole system by toxic products has been demonstrated by Mosso, who found that by injecting blood from a fatigued animal into the veins of a fresh animal all the symptoms of fatigue were produced in the latter.[3] Fatigue is generally first produced in the delicate nervous mechanism of the brain and spinal cord—before the muscle is fatigued the source of the impulses

[1] Cf. Stanley Kent in *Industrial Administration*, p. 190, " Fatigue may be likened, not to the stoppage of an engine for want of fuel, but rather to a stoppage caused by the clogging of the mechanism with dirt."

[2] Cf. Stanley Kent in *Industrial Administration*, p. 189.

[3] Cf. Stanley Kent, op. cit., p. 190 ; J. A. Hobson, *Work and Wealth*, pp. 65–66 ; and *Industrial Efficiency and Fatigue*, p. 9.

which cause its contractions becomes impotent. The muscles are further protected by the fact that the nerve fibres which conduct the impulses to the muscles are connected with the muscle by end plates which are very sensitive to fatigue and fail to transmit the impulse to the muscle. The end plates are in turn protected from the rapid development of fatigue by the setting up of nervous impulses which are carried back to the spinal cord along the sensory nerves and tend to prevent the outgoing stimulus along the motor nerve to the muscle. This means that additional power must be used to overcome this tendency if the impulse is to reach the muscle.[1] This need for increased impulses as fatigue develops is added to by the increased resistance to the impulse at the synapses—the junctions of the different processes which make up the nerve fibre—which is due to the accumulation of toxic products in the nervous system. It is this increased resistance which is held to account for the fact that as one particular set of muscles becomes fatigued the

[1] Cf. Myers, *Mind and Work*, pp. 39–46; Drever, *The Psychology of Industry*, pp. 61–73; Muscio, *Lectures on Industrial Psychology*, p. 90; J. A. Hobson, op. cit., p. 66.

neighbouring muscles begin to be contracted as the greater impulse now necessary overflows, as it were, and overcomes resistance in the nerve fibres to other muscles which had been protected before fatigue set in.[1]

Habit, formed by practice, seems to have the effect of making a greater number of contractions possible by lessening this innervation or overflow of impulses and, by much use, improving the routes of connection between brain and muscle.[2] There seems to be a tendency towards automatic action, but the effects of habit may be overcome by the development of "monotony"—which leads to "boredom," a state in which the pleasurable incentive in the work fails. Boredom is difficult to differentiate from "weariness" and fatigue, which it simulates, but it can be dispelled by a change of occupation. If, however, work is continued after "boredom" is felt there is a very rapid development of "weariness"—the subjective feeling which

[1] A tired walker seems to "walk with the whole of his body." In experiments with the Ergograph, if three fingers are left free and the middle finger contracted, when fatigue develops the other fingers begin to contract too. Cf. *Industrial Efficiency and Fatigue*, p. 9.

[2] Cf. Muscio, op. cit., p. 90, and also *Industrial Efficiency and Fatigue*, pp. 9–11.

denotes the impairment of the efficiency of those processes which enable us to concentrate on a single activity or maintain the special attitude which is necessary even to habitual actions. Continual activity at the same work when "weariness" has set in rapidly produces dangerous central fatigue, and even a change of occupation is not effective in dispelling it as the toxic products accumulated in the nervous system act on the synapses of the brain so that all concentration is weakened.

From this account of the physiological nature of fatigue it will be seen that (*a*) the fatigue produced by industrial activities, whether predominantly muscular or mental, is fatigue of the nervous system; (*b*) that as fatigue progresses a disproportionate amount of energy must be expended to produce a similar quantity of work;[1] and (*c*) that "boredom," due to lack of interest, is too harmful in its effects to be ignored.[2] From (*b*) it follows that fatigue is not proportionate

[1] Cf. *I.F.R.B. Report, xv.* As girls engaged in "roughing" spoons and forks grew tired, and output diminished towards the end of the day, the girls tended to give more vigorous and more numerous strokes per unit of output—not only working slower than when fresh, but expending energy extravagantly, pp. 45–54.

[2] Cf. Drever, op. cit., p. 72.

to the duration of a task, " for even a slight lengthening of a task may result in the production of an altogether disproportionate amount of fatigue."[1]

Before it is possible to pursue our inquiry farther it is necessary to find out by what means fatigue can be detected and to what extent and by what means it can be measured.

For this purpose the most familiar manifestation of fatigue—the subjective feelings of weariness which we have most of us experienced—are of little use. The investigations of the Health of Munition Workers Committee into the nature and causes of Industrial Fatigue have given us some of the most reliable and valuable information on the subject. In their report they lay stress on the fact that " the objective results of fatigue often precede in their onset the subjective symptoms."[2]

" Without obvious sign and without his knowing it himself, a man's capacity for work may diminish owing to his unrecognised fatigue." Moreover, Rivers showed that " in

[1] Cf. *Industrial Fatigue by Physiological Methods*, Stanley Kent, p. 7.

[2] *Industrial Efficiency and Fatigue*, p. 11.

the performance of mental work especially decided symptoms of fatigue may be experienced when the objective record shows that increasing and not decreasing amounts of work are being done," while in other cases, as shown above, "there may be complete absence of any sensations of fatigue when the objective record shows that the work is falling off in quantity or in quality or in both."[1] Dr. Myers holds that feeling fresh does not always indicate a high capacity for work, as at a certain stage fatigue may produce a feeling of ability to work well which is not reflected by the quantity or quality of the output.[2] Not only are the subjective sensations of fatigue uncertain and unpunctual, but they cannot be measured. On the other hand, it has been shown by Muscio "that felt tiredness has a significant correlation with fatigue tested objectively,"[3] and we may use it with caution as a test of the success of attempts to eliminate fatigue provided that it is well supported by objective evidence.

[1] Rivers, quoted by T. H. Pear, in *Industrial Administration*, pp. 40 and 41.

[2] Myers, *Mind and Work*, p. 47.

[3] Eric Farmer, "The Economy of Human Effort in Industry," *N.I.I.P.J.*, p. 19.

The objective tests to discover and in some degree to measure fatigue may be divided into three classes:

(*a*) Those tests which attempt to discover fatigue by measuring the direct effect on the muscles concerned, or the indirect effect on some subsidiary function which is assumed to deteriorate as central fatigue sets in.[1]

(*b*) Laboratory tests which measure fatigue by measuring the quantity and quality of some simple kind of mental or physical work done.

(*c*) Industrial tests which are of use in measuring the fatigue produced by the complex activities of industrial processes.

(*a*) These tests include such tests as the Dynamometer, which measures by means of a sort of spring balance the pull of a set of muscles, and a great variety of indirect tests such as the "Æsthesiometric index" given by measuring the shortest distance between two points at which they are felt to be two; the "Algesimeter," which tests sensitiveness to pain; Reaction-time, the "Reversible perspective" test, tests for acuity of sight and hearing, etc. These tests are all subject to the disadvantage of being easily affected

[1] Myers, op. cit., pp. 56 and 57, and Drever, op. cit., pp. 68–70.

by emotional state, by simulation of fatigue and, if interpolated during work-time, to changes due to the pleasure or irritation of the subject on being taken from work for the test and to interest in the desired result.[1] There are certain tests of this group which are free from some of these disadvantages as they are not under the control of the subject and so are free from danger of simulation, etc. Respiration, circulation of the blood, the electric resistance of the skin are examples of such tests, but even they are affected by emotional changes. Further, the exact significance of some of these changes is not definitely known, e.g. the sensitiveness to pain may increase or decrease with fatigue. Broadly speaking, these tests give no satisfactory index of fatigue and are only of use in corroborating evidence obtained by other means.

(*b*) These tests are of greater value than those of group (*a*), and from them has been obtained much of the most valuable information so far gained on this subject. One form in which they are used is that of Mental Tests —the quantity and quality of the work done

[1] Cf. *Industrial Efficiency and Fatigue*, pp. 13 and 14.

in a " performance test " such as Cancellation, Calculation (the addition of single digits) or McDougall's Dot test is measured for equal and consecutive periods, allowance is made for practice, adaptation[1] and even muscular fatigue in some cases and central fatigue is judged by the deterioration in output. " Despite the complex factors (local and general, higher and lower, metabolic and inhibitory, boredom and weariness) that affect output and are inseparable from fatigue, we seem forced (but only with approximate accuracy) to assume that " fatigue " is generally proportionate to the reduction in output."[2] Perhaps the most reliable of these experiments are those which are carried out with the Ergograph—an instrument which enables the study of fatigue in a single muscle of the human body and records the number and the extent of its successive contractions during a certain period or until complete impotence is reached. The fatigue which is produced by muscular contractions under the conditions of these experiments is largely due to the monotony of the work in the specially

[1] The effects will be discussed later, cf. pp. 82 and 90.
[2] Myers, op. cit., p. 53.

narrow range of activity fixed by the apparatus. This is shown by the fact that if the conditions are changed—if the weight attached to the contracting finger in the usual arrangement of the apparatus (in which the forearm is fixed in a clamp, the fingers except for the middle finger are fixed in cases which allow of no movement at all, and the middle finger is attached to a weight the movements of which as the finger is contracted and straightened are recorded on a smoked drum) is changed, or if either the first or third finger or both are released—a new ergogram can be obtained from a muscle which appeared to be impotent. The main discoveries which have been made from the use of the Ergograph are :[1]

i. If the muscle is contracted continuously, without an interval between contractions, a condition is very rapidly reached in which the weight cannot be moved at all. If a sufficiently long pause be given between contractions no apparent fatigue results. This was found when a six kilogram weight was used and ten seconds' pause between contractions, but when two seconds only was allowed,

[1] Cf. Myers, op. cit., pp. 43–44; Drever, op. cit., pp. 55 and 56; Muscio, *Lectures on Industrial Psychology*, pp. 81–88.

inability to contract resulted in about one minute. The best work is done when a definite rest period is interposed at regular intervals. For example, Myers found that with a certain weight, if the finger was contracted thirty times in sixty seconds, two hours were necessary before an equal quantity of work could be done again. If fifteen contractions were made in thirty seconds only one half of an hour's rest was needed for recovery. Muscio found that if ten seconds' rest was given after each contraction no apparent fatigue resulted. From these figures he calculated that, if these three different arrangements of pauses could be followed throughout an eight-hour day with similar results, the daily output would be 120 when thirty contractions were followed by two hours' rest, 240 when fifteen were done and then half an hour's pause allowed; and 2,400 when each contraction was followed by a pause of ten seconds. Even though these results might be modified in an eight-hours' test, the principle which they illustrate is clearly of great importance.[1]

ii. The Ergograph has also shown that the maximum of work can be done with a certain definite load, and that if this load be either increased or decreased, less work can be done.

iii. From "work curves," showing the distribution of output measured at short and regular intervals over a long period, obtained from experiments with this apparatus, and also from the performance of mental work, it has been found that

[1] Muscio, op. cit., pp. 83–85.

the rate of output is not constant but varies with the changing effects of contending influences. The effect of practice, of "warming up" to the work, and of "settlement" (that is, the ability to overcome external and internal distractions) is to increase the rate of output, while the effect of "boredom," "weariness" and fatigue is to diminish it. It has also been noticed that the rate is influenced by "spurts," which seem to reflect changes in the emotional state or mental attitude of the subject. A marked "beginning spurt" is often found which may be due to the interest and freshness with which the worker attacks his task; this is usually followed by a fall and later by a great rise due to the combined influences of incitement, settlement and practice. As fatigue develops there is a falling off which is usually followed, if the subject is conscious that the end of his task is near, by a marked "end spurt," probably due to the anticipatory feelings of pleasure aroused by thoughts of rest and food.

These discoveries have been supported by investigations made under normal conditions, the results of which are given below.

(*c*) Although tests made under industrial conditions are the most difficult to apply as the number of variables is very great, it is from this source that we get the most reliable confirmation of principles discovered by laboratory tests. Industrial tests include careful

study of the work curves given by measuring the output of workers at regular intervals of the day over a considerable period and of the effects on the rate of output of different changes in the conditions of work. In some cases fatigue may be detected and measured by measuring the machine power used[1] at different periods of the day. A further test is furnished by statistics showing the amount of spoiled work and the number of accidents, but care must be taken to make allowances for other variables which affect these figures, and a valuable check on the accuracy of results obtained from these tests is given by the figures for lost time and sickness taken over a sufficiently long period. Many of the earlier experiments carried out under actual workshop conditions lost much of their value because several changes were introduced at the same time; but in the more recent examples which I shall quote in illustration of the main principles discovered or confirmed by these tests, care was taken to avoid, as far as possible, making more than one change at a time, so that any changes shown by the above tests can with a high degree of proba-

[1] Drever, op. cit., p. 71.

bility be ascribed to the particular change which was introduced in the experiment.

The first series of experiments which we must consider are those relating to the introduction of rest pauses, the benefits of which were suggested by the discoveries made from laboratory tests.

The effects of the introduction of a rest pause during a period of work are :

i. To allow recovery from fatigue.

ii. To allow the human organism to become cool —to lose the effects of incitement, and, if prolonged, of settlement, and

iii. If still further prolonged to cause the loss of practice effects.

These effects differ with the individual, the type of work being performed, the amount of fatigue present, the length of the pause and the distribution of pauses in the working day. As we have already seen, a short rest may suffice to allow recuperation if fatigue is slight, but the rest needed to allow recovery grows rapidly and progressively when the fatigue point has been reached.[1] The distribution

[1] Cf. Gilbreth, *Fatigue Study*, p. 5, " Fatigue Advances in Geometric Procession " ; also J. A. Hobson, *Work and Wealth*, p. 66.

and length of the pauses necessary to eliminate or lessen fatigue depend largely on the type of work. Heavy physical work is best performed in short spells with longer rest periods—in the case of Pig Iron Loading, Taylor found that with 92 lb. pigs 43 per cent of the time only should be spent under load—that is, seven minutes' work was followed by ten minutes' rest; while with a half-pig of 46 lb. the best results were obtained if 58 per cent of the time was spent under load. In mental work, however, the process of "warming up" takes longer, and if pauses are introduced too early the process may be disturbed. An interruption before the worker is "warmed up" may spoil the work of the whole period, and even when "settlement" has set in too long a pause may do more harm than good. By experiment it can be found what length of pause is necessary to allow recovery from fatigue without a greater loss of incitement and settlement, so that efficiency is exactly equal after the pause to what it was before, and also what is "the most favourable pause" from which the greatest net gain in efficiency can be obtained. The total length, number and distribution of

pauses and the nature of the rest taken are factors of enormous importance, and here once again subjective feelings are not a safe guide.[1] Girls employed on a very monotonous process in a bleaching works were given two rest periods of forty-five minutes and a midday break of forty-five minutes for dinner. On the advice of Mr. Gantt this was changed and a twenty minutes' break was given after every eighty minutes' work. As a result there was a 60 per cent increase in output.[2] Girls working in another part of the works were allowed to choose and, following the guide of their subjective feelings, chose two long breaks rather than more numerous shorter breaks. This arrangement did not prove so satisfactory. If rest pauses are to be correctly used there is need for an investigation by experts skilled in the application of psychology to industry to determine when, for how long and how frequently they should be introduced. The value of rest pauses is shown by the results of the following experiments:

[1] Cf. T. H. Pear, article on "The Application of Psychology to Industry," *Industrial Administration*, pp. 25–47.

[2] McKillop, *Efficiency Methods*, p. 102; Myers, op. cit., p. 72 and others.

(*a*) Dr. Myers reports that the result of introducing a ten minutes' rest pause in each spell of a ten hour day was an increase of 3 per cent in output in the first period under observation, 17 per cent during the second period and 26 per cent in the third. The human organism seems to need time in which to adjust itself to the new conditions before the maximum results are achieved.[1]

(*b*) In a munition factory men engaged in heavy moulding work were asked by the manager to rest fifteen minutes after every forty-five minutes' work. As they were paid by the piece and feared a loss of wages by losing so much time they refused, and it was necessary to enforce the rest pauses by keeping a foreman over them to time them and see that they rested. Despite the unwillingness of the men, which might have produced an emotional state deleterious to output, the output was increased.[2]

(*c*) Two officers, for a friendly wager, competed in getting equal lengths of trench dug with equal squads of men. The one divided his men into three groups and set each to work in turn so that they worked for five minutes and rested for ten. The other set his men to work as hard as they could, resting only when they were obliged. The former squad won easily.[3]

(*d*) This experiment has been applied in the

[1] Myers, op. cit., p. 72.
[2] *Industrial Efficiency and Fatigue*, p. 16.
[3] *Ibid.*, p. 10, footnote.

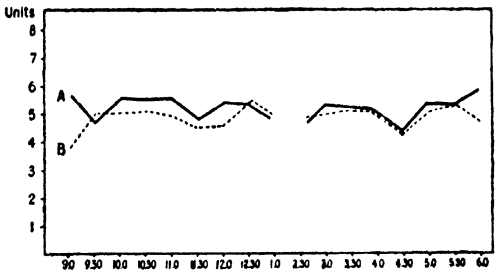
bottle-making industry, where three teams have been employed for two machines, each team having twenty minutes' rest after forty minutes' work. The result has been greater output per man with less apparent fatigue.[1]

(*e*) In a boot and shoe factory during the war it was desired to increase output substantially without laying down new machines, a desire felt by every manufacturer in times when demand is very great. The workers were doing forty-one hours a week in five days. Each double press, which was usually worked by two girls working continuously, was now equipped with a team of three girls each working for forty minutes in each hour and resting twenty. The increases in output for the six presses were 45, 34, 57, 37, 43 and 75 per cent, the total increase in output being 44 per cent. A period of adaptation was observed to be necessary in this case, too, before maximum efficiency was reached. This phenomenon has been recorded in many other cases too numerous to quote.[2]

(*f*) In the case of girls doing light physical work demanding close attention and requiring a high standard of quality to be maintained, employed from 8.30 a.m. to 6 p.m. with an hour's break at 1 o'clock, making a total of forty-six hours in a five-and-a-half day week, and paid good wages on a time basis, the experiment was tried of introducing rest pauses of seven minutes' duration at 11 a.m. and 4 p.m.—tea being provided during the

[1] Myers, op. cit., p. 74.
[2] *I.F.R.B. Report*, *x*, pp. 28–32.

afternoon pause. As a result the total output increased from 83·4 units per week to 88 units, an increase of 5·47 per cent, despite a decrease of nearly 3 per cent in the hours worked. Observation was possible only for four weeks, so that the time necessary for adaptation was not allowed, and the results can be expected to be greater still when the full effects of the change are felt. The work curve below enables us to detect other improvements besides the increase of output.



A. The unbroken line (88 units), two weeks' average output with rest pauses.

B. The broken line (83·437 units), one week's average output without rest pauses.

If we allow for the short periods—twenty-three minutes instead of thirty from 11.7 to 11.30 a.m.; 4.7 to 4.30 p.m.—we find that the work curve is more regular in case A than in case B. The decline before 1.0 a.m. is less

marked, and the end spurt shown in curve B is not apparent in curve A. During the afternoon output is better sustained, and towards the end of the afternoon instead of falling off rises rapidly in the last half-hour. In both cases the output during the twenty-three minutes of the short period is greater than that for the full thirty minutes for the corresponding period before the rest pauses were introduced. The shape of the work curve may often, as is here shown, indicate more than the bare figures of total output can do. A well-sustained output with no falling off towards the end of the day combined in this case with the subjective evidence of the girls, who said they felt far less tired at the end of the day, indicates that there is a great probability that fatigue has been diminished even though output has been increased.[1]

The results of these experiments, while in no way complete, suggest the enormous savings which the scientific use of rest pauses may make not only directly by increasing output without increasing machinery, work-

[1] Cf. "An Experiment in the Introduction of Rest Pauses," *N.I.I.P.J.*, pp. 89–92.

rooms, etc., and so adding to overhead charges, but also by lessening the subjective sensations of fatigue which prevent the enjoyment of leisure and cause unrest, and so tend to add to the waste caused by excessive labour turnover.[1]

The increases in output due to the introduction of rest pauses are brought about, it appears, by the retarding of the development of fatigue. It is therefore to be believed that the elimination of excessive fatigue might still further increase output.[2] Normally the fatigue developed during the day's work is eliminated during the rest of the evening and especially during the sleep of the night. But if the fatigue is excessive or the rest period insufficient, fatigue accumulates with increasing rapidity and is eliminated during the week-end rest, unless once again the fatigue is excessive or the week-end rest period insufficient.[3] Just as it seems that the rate of output depends as much on the distribution of the hours of work as on their length, so it may be shown weekly and monthly output

[1] Cf. Chapter II, p. 27.

[2] Cf. Drever, op. cit., p. 78.

[3] Cf. *Industrial Fatigue by Physiological Methods*, Stanley Kent, p. 49.

depend to a great extent on the distribution of work and rest throughout the week. From laboratory experiments we are led to expect that, just as there is an optimal load which gives the best results, so also there is a total length of work per day and week which will give the greatest possible efficiency as shown by output. Experiments and investigations made under normal factory conditions tend to support this suggestion by showing that a decrease in output and an increase in lost time, sickness, accidents and spoilt work may result from the working of long hours and may be remedied by a shortening of the working day. The examples which follow are taken from the reports made by investigators during the war. There was urgent need during this period for the maximum output from all factories engaged on munition work, and in the early days of the war, acting "on the baseless assumption that long hours mean high output,"[1] workers and managers alike put in as many hours a week at their work as it was humanly possible to do. When doubt was thrown on the efficacy of this method to get maximum output, investiga-

[1] *Industrial Efficiency and Fatigue*, p. 13.

tions were made with the object of finding what length of working day actually would give the maximum results over a period of months, or may be even years. No objections would be raised by the workers however long these hours might be so long as health and physical efficiency were not impaired, and no account was to be taken of the costs of production—if an extra unit could be produced at a higher cost it was to be produced.[1] The value of the results of these investigations was increased by the fact that they were based on actual shop records and not on records made from workers under observation who are nearly always emotionally affected in different ways and in incalculable degrees by the presence of observers.[2]

i. Examples showing increases in output following on the reduction of hours of labour :

(*a*) Women engaged in the moderately heavy manual labour of "turning fuse bodies," were working 74·8 nominal hours a week (68·2 actual hours of work) with an average (relative) output of 6,820 per week. The nominal hours were reduced to 67·5 (actual hours of work, 61·6), and as there

[1] Cf. *Industrial Efficiency and Fatigue*, pp. 17 and 18.
[2] Cf. Sir Wm. Ashley, *Lectures on Commerce*, II.

was no immediate effect on the hourly output the total relative output fell to 6,591 units. As the effect of shorter hours became established, and a further reduction to 64·3 nominal hours (average actual hours of work 59·7 per week) took place output increased—the relative output per hour rose from 100 to 123, and the total relative output to 7,343 units per week—an increase of 8 per cent in approximately 12 per cent less time.[1]

(*b*) Men engaged in the heavy work of "sizing fuses," which is carried on independently of machinery, had their hours reduced from 58·2 to 50·6 —a reduction of 13 per cent. Their hourly rate increased 39 per cent, their total output 21 per cent.[2]

(*c*) The hours of women engaged in "turning fuse bodies," which is partly dependent on the speed of machinery, were reduced from 66 to 48·6 per week—a reduction of 26 per cent, and the result was a 68 per cent increase in hourly output, and a 15 per cent increase in total output.[3]

(*d*) Five voluntary Sunday workers working eight hours exceeded considerably the output of week-day workers doing a fourteen hours' day. That is to say that, if they had worked only four days of eight hours a week, they would have done more than workers doing fourteen hours a day for a full week. As the week-day workers were, under the influence of patriotic motives, working their hardest, it seems

[1] *Industrial Efficiency and Fatigue*, p. 18.
[2] Cf. Myers, *Mind and Work*, p. 75.
[3] *Ibid.*, p. 76.

probable that they could have increased their output if their time-table had been better arranged.[1]

(*e*) The hours of youths engaged in "sizing base plugs" were reduced from 70·3 to 57·0 a week. The hourly rate increased 42 per cent and the total output 19 per cent. A fortnight later, for a period of three weeks, the hourly output was 55 per cent above the rate before hours were reduced—the total output 38 per cent above.[2]

(*f*) A most important case, which was carefully investigated by Dr. Stanley Kent, and which will be referred to again later, was that of women engaged in Winding Surgical Dressings. Although payment for this work was by the piece, it was found that one woman very rarely worked overtime and never worked a pre-breakfast period, of two hours, because she said "the extra rest enabled her to work so much more quickly that she was able easily to make up for lost time." A careful record was made for a month of the output for each period worked by No. 14a, as this worker was labelled, and of that of three other workers selected for their speed. No. 14a worked eight hours a day, 8.30 to 12.30 and 1.30 to 5.30 and was absent for one whole day and three half-days during the month. In 160 hours she wound 52,429 bobbins. The other three workers worked twelve hours a day for the first fortnight, 6 to 8 before breakfast, and 6 to 8 in the evening overtime, and ten hours, no overtime, during the last fortnight, an average of 237 hours'

[1] *Industrial Efficiency and Fatigue*, p. 13.
[2] *Ibid.*, p. 21.

work. The output of the best of them was 51,601 bobbins, their average output 48,529. The output of the three other workers increased by 5 per cent during the fortnight in which no overtime was worked. No. 14a was not a faster worker than it was possible for the others to be, as at times their output for a four-hour period was greater than hers, but they were unable to maintain the speed because, Dr. Kent suggests, the rate was limited by the fatigue of the workers.[1]

(*g*) The total weekly output of women "turning fuse bodies" was the same during a 54·4 hour week as during a 66 hour week, and increased 13 per cent when hours were further reduced to 47·5 hours per week. For four weeks after the first change hourly output was unchanged, then it rose irregularly from an average of 108 to 131. For two weeks after the second change no change took place in hourly output, but later it rose gradually to 169. The need for a period of accommodation before the full results of a change become apparent is clearly shown.[2]

From these examples, which could be supported by many others were there space, it seems that there is a definite length of working day which produces the greatest output and which to increase will be to diminish not only the hourly rate, but often the total output also. If this be so, it is uneconomical from

[1] *Industrial Fatigue by Physiological Methods*, pp. 37–41.
[2] *I.F.R.B. Report, vi*, pp. 8–14.

every point of view to force workers to work longer hours under any circumstances. This statement is disputed by Mr. Harrington Emerson,[1] who maintains that it is misleading to say that shorter hours can ever increase output. He explains statistics of the earlier experiments, such as that at the Bicycle Ball Factory quoted by Taylor, in which the shortening of the hours from 10½–10–9½–9–8½ resulted at each step in increased output[2] by saying that the old type of factory was only 35 per cent efficient, and when hours were shortened the methods were changed too and made more efficient, and this caused the output to increase instead of to diminish. He points to sporting records to prove that more is always done in a longer time. This second point is of little value, as the conditions of a race are very different from those of a factory. Obviously, however much work a man has done, by a supreme effort he could do a little more in a longer time, but only by incurring a more than proportionate amount of fatigue which, under industrial conditions where the work is carried on day after day, week after

[1] Cf. Muscio, op. cit., pp. 72, 73.

[2] F. W. Taylor, *The Principles of Scientific Management*, pp. 86–97.

week, year after year, would result in a lessened output on succeeding days and perhaps to complete inability to work for a considerable time.[1] There was a great deal of truth in his first point as applied to many of the earlier experiments in diminishing the hours of labour. Much of the increase was due to improved machinery and methods.[2] But in the experiments and investigations, of which I have given the results above, care was taken that no other factor was involved. For example, in case (*f*) the only difference between different workers was the number of hours worked. With reference to case (*a*) Dr. Vernon says, " It might be thought that the great improvement in hourly output under the shorter hours' regime was due, partly or wholly, to increased skill of the operatives or improvements in the machinery. Neither of these hypotheses can be substantiated."[3] On investigation there was found to be little difference in skill between two groups, one of which had been engaged in turning fuse bodies for five months previous to the statis-

[1] Cf. Drever, op. cit., p. 79.

[2] Cf. Sir Wm. Ashley, *Lectures on Commerce*, II, " The Effect of the Ten-Hour Act."

[3] *Industrial Efficiency and Fatigue*, p. 18.

tical period, and the other for one and a half months only. "No change had been made in the tools, the machinery, the nature of the operation, or the quality of the alloy used during the statistical period dealt with, or for four and a half months previous to it." Moreover, this statement is confirmed by the fact that a group of workers which when working only 51·8 to 62·6 hours per week, instead of the usual 75 to 77 hours, was producing 18 per cent more per hour than a group working the longer hours, was put on to the longer hours when the output of the two groups became identical.[1]

Dr. Stanley Kent has given a physiological explanation of this astounding result which seems to upset, as modern science so often does, what had seemed to be a commonsense belief—that longer hours imply increased output.[2] When a man is working to his full strength, as is normal in industry to-day, most of his energy is expended by the evening. Next morning he has a new supply available which carries him on for another

[1] *Industrial Efficiency and Fatigue*, p. 19.

[2] Cf. T. H. Pear, "The Applications of Psychology to Industry," *Industrial Administration*, p. 26.

day, but as the course of recovery at night is seldom perfect " an increasing debit balance is carried forward from day to day to be liquidated at the week-end." In this way equilibrium is maintained between the forces of destruction and those of restoration. The factors on which depend the maintenance of this equilibrium are :

i. The original store of energy.
ii. The rate at which it is expended.
iii. The rate at which it is regenerated.
iv. The length of the period of labour.

Of these the only factor which can be varied quickly at the will of the worker if the other factors are changed and the equilibrium destroyed is (ii), which depends upon the degree of application of the worker to his task. If, when the system is in equilibrium, the hours of labour are extended—as, for example, by the introduction of overtime—the balance of expenditure and regeneration is upset, fatigue becomes disproportionately great, yet the time for recovery from fatigue becomes shorter, and to prevent a complete breakdown a readjustment is necessary. This can only be brought about by " balancing," the " adjustment of the application of the worker to

his task," so that although extra hours are worked application will be relaxed and the fatigue produced per hour will be diminished. As a result the general efficiency of the worker will be lessened and the total output may be decreased, so that the overtime may often defeat its own object—the increase of output.[1] To this physiological explanation must be added other partial explanations—some of the increase is due to decreases in lost time, in the number of accidents, and the amount of spoiled work and in the diminished rate of labour turnover, as well as to the fact that there is a tendency for short hours to encourage the invention and installation of faster machines and better systems of management, although this stimulus may not be felt immediately.

ii. Examples showing decreases in the amount of lost time, sickness, accidents, spoiled work and rate of labour turnover:

(*a*) Stanley Kent found from a careful investigation that, "where an estimate was made of the time lost by the worker . . . the suspension of overtime was found to result in a saving of 4½ per cent. The subsequent suspension of the early

[1] Cf. Stanley Kent, *Industrial Fatigue by Physiological Methods*, pp. 48–50.

morning period was followed by a further diminution in the time lost." [1]

(*b*) Mr. T. Loveday in "The Causes and Conditions of Lost Time" [2] reports that "the effect of long hours, much overtime, and especially of Sunday labour, upon health, is undoubtedly most deleterious. In one factory in the Midlands . . . in the spring, no fewer than 22 per cent of the men were at one time sick; but the number of men on the sick-list in August, when Sunday work had been much reduced, was only a trifle over 4 per cent of the whole body . . . and I see no reason to doubt the manager's view that the weather was less accountable for the change than the restriction of Sunday labour." [3]

(*c*) The following records show the change in absenteeism in two large factories employing female labour, by comparing the figures for six months before the change from 55 hours to 49 hours a week with those for the six months after it.

I

	Before	After
Average number of hours lost each week overhead for any reason	3·77	2·54
Percentage of gross possible hours lost for any reason	6·84	5·16
Percentage of employees absent one morning a week . .	10·93 (For 3 hours).	2·51 (For 4½ hours).

[1] Cf. Stanley Kent, *Industrial Fatigue by Physiological Methods*, p. 65.

[2] *Industrial Efficiency and Fatigue*, pp. 41–67.

[3] *Ibid.*, p. 53.

II

	Before	After
Average number of hours lost each week overhead for any reason	2·66	1·85
Percentage of gross possible hours lost for any reason .	4·8	3·8
Percentage of employees absent at all for any reason . .	18·0	7·6

The investigation reported that piece workers' earnings on an average were increased owing to their more regular attendance and greater vigour; health was improved; work was better both in quality and quantity; and the total output was increased although even taking into account the better attendance, the number of hours worked was reduced.[1]

(*d*) Muscio [2] gives figures obtained in Germany, in investigations in connection with a compensation for accidents scheme, which show that the number of accidents was disproportionately great in the last two hours of each spell of work. Statistics obtained in U.S.A., England, France, Belgium and Italy show a remarkable correlation between tables showing the number of accidents at various hours of the day. This is explained by the fact that fatigue shows itself early in a want of co-ordination between brain and muscle, and in the failure of the power of concentration. This may not be subjectively realised, but is "shown objectively by an

[1] Table and report taken from the above report, p. 59.
[2] Op. cit., p. 53.

increase in trifling accidents due to momentary loss of attention." [1]

(*e*) Perhaps the subjective evidence of a keen [2] observer, with factory experience, may be heard with advantage on this point :

"Since Thursday he'd been working overtime,
With only three short hours for food and sleep,
When no sleep came, because of the dull beat
Of his fagged brain. . . .
And though at first the colours made him glad
They soon were dancing in his brain like mad;
And kept on flaring through his burning head:
Now, in a flash, the workshop flaming red;
Now blazing green, now staring blue;
And then the yellow glow too well he knew:
Until the sleek machine with roar and glare,
Began to take him in a dazzling snare,
When fascinated with a senseless stare,
It drew him slowly towards it, till his hair
Was caught betwixt the rollers; but his hand
Almost before his brain could understand
Had clutched the lever, and the wheels were stopped
. . . . ."

(*f*) In an investigation into "Spoiled Work in Industry, with reference to the Time of Day and Type of Operation," A. H. Ryan and P. Sargant Florence [3] found that spoiled work was most abundant at the beginning and near the end of the day, and that where a fast pace was set by a machine

[1] *Industrial Efficiency and Fatigue*, p. 13.

[2] Wilfrid Wilson Gibson, *The Machine*.

[3] Investigations for the N.I.I.P., see *Journal*, pp. 193–197.

it increased steadily throughout the day. It was found to be greatest where the work demanded fine sensory discrimination.

(*g*) The effect of shorter hours combined with better wages, and an attempt at vocational selection on labour turnover, is shown by the comparison of an eight-hour plant in U.S.A., where labour turnover was only 30 per cent during the year of observation with a ten-hour plant where it was 176 per cent.[1]

This evidence is further substantiated by the mass of statistics which were obtained by war-time committees appointed to investigate the industrial problems raised by the shortage of labour and the need for enormously increased output of certain products. As a result of these discoveries the truth of Dr. Stanley Kent's words, with which this chapter opens, seems obvious. Excessive fatigue not only diminishes output, but also increases the number of accidents, the waste due to spoiled work and the waste due to excessive labour turnover, and makes the workers less efficient and less satisfied because of the ill-health which it produces.

The evidence on these points has been set

[1] *United States Public Health Bulletins*, No. 106, pp. 155–174; abstracted *N.I.I.P.J.*, p. 201.

out at great length because of the importance of the conclusions to which it leads.

i. The discovery that there is in all probability an optimal length of day which will give the maximum output under normal industrial conditions for the minimum outlay per unit of human effort, capital[1] and overhead expenses[2] seems to simplify greatly the question of the hours of labour over which many industrial disputes between employers and workers have arisen. Obviously if, as all the evidence seems to prove, this is true, the maximum hours which it will be to the interest of employers to employ the workers can only be settled by investigation into the particular industry by specially trained experts who should be under the joint control of the workers and the management.[3] It does not follow, of course, that the optimal length of day from the point of view of output will be accepted by the workers, for, in some industries it might be far longer than present

[1] If a greater output can be obtained from the same machines, factory, etc., the capital charges per unit will be decreased.

[2] The overhead expenses will be decreased by diminution of labour turnover, spoiled work, etc.

[3] Cf. settling of cotton piece rates for different machines.

hours, although the evidence seems to show that in most cases it would be shorter. If it were longer, the question would have to be settled by bargaining, as part of the reward of workers in some industries is paid in increased leisure. Teachers, for example, get lower wages than workers so highly trained and needing such initial ability normally command, because of their longer holidays and shorter hours. The joint control of the expert by workers and employers seems to me to be essential to the success of the scheme. The experiences of the last century, during which it has been almost universal for employers, following tradition rather than experiment, to disobey physiological laws in the supposed interests of gain[1] has aroused suspicion in the workers, so that they would not be likely to accept the findings of an expert whose whole future was in the hands of the employers.

ii. The second conclusion follows closely on the first. If the optimal day is being worked it is uneconomical to work overtime; if it is not being worked, the number of hours of overtime which can be worked with profit to the employer is the difference between the

[1] Cf. *Industrial Efficiency and Fatigue*, p. 12.

number of hours now worked and the optimal number of hours. This conclusion is confirmed by the discovery of Myers[1] and Vernon[2] that if, when hours have been reduced and after the usual period of adaptation, output has increased, the old long hours are reintroduced, the result is an immediate return to the old, slower rate of output—due to the often unconscious process of "balancing." This is illustrated by the work curve[3] reproduced opposite, which shows the successive changes in output following on a decrease in the hours of labour of Tinplate Millmen and the subsequent return to the longer hours.

If overtime were worked on two or three nights a week the result would be that throughout the whole week the hourly rate of output would be that of an eight-hour shift instead of that of a six-hour shift, and some time would be needed on going back to the shorter hours for adaptation to take place.[4] The vexed question of overtime

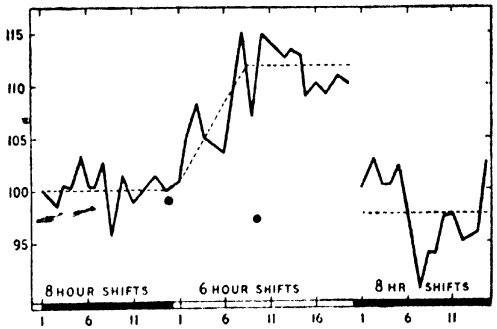
[1] Op. cit., p. 79.

[2] "Output in Relation to Hours of Work" in *Industrial Efficiency and Fatigue* and *Industrial Fatigue and Efficiency*, Dr. H. M. Vernon.

[3] Taken from *I.F.R.B. Report*, No. vi.

[4] Cf. *N.I.I.P.J.*, p. 44.

could therefore be settled without trouble if the discoveries of physiology and psychology were applied to its solution. How is it, we are led to wonder, that if this is the case overtime has ever been worked as a means of increasing output? The answer may be partly because of ignorance of its effects over



a long period of time (it took two years of war-time experience to teach the lesson to munition factory managers), partly because its effects are not in some cases immediate but are due to the accumulation of fatigue,[1] and partly because in some cases there is restriction of output during the day to such an

[1] This suggestion was put forward in conversation by Dr. Myers in March, 1923.

extent that there is a reserve of energy at the end of the day.[1]

It is to be feared that much of the valuable experience gained during the war period has been forgotten,[2] and with it the advice and warning given by the Health of Munition Workers Committee in its Interim Report. It would be well if our industrialists would read it and take note.

"It is certain," they say, "that unless our industrial life is to be guided in the future by the application of physiological science to the details of its management, it cannot hope to maintain its position hereafter among some of its foreign rivals, who already in that respect have gained a present advantage."[3]

[1] In some cases, too, the optimal length of day may exceed the hours worked.

[2] Sir Wm. Ashley, *Lectures on Commerce*, II.

[3] *Industrial Efficiency and Fatigue*, p. 16.

CHAPTER IV

MOTION STUDY AND THE ADJUSTMENT OF MATERIAL CONDITIONS TO THE WORKER

ONE of the most important of the innovations introduced by the American Efficiency Engineer, and one which has aroused great interest and keen opposition in many quarters, is the study of the speed and manner of the motions involved in the performance of an industrial operation and the evolution of new methods assumed to be more efficient. The method favoured by Taylor[1] and highly developed by Gilbreth[2] consisted in analysing the job—dividing each cycle of motions into its constituent elements and observing the method used and the time taken for each element by a number of workers skilled in the job and taken if possible from widely different fac-

[1] Taylor, *The Principles of Scientific Management*, pp. 118 and 119 and elsewhere, and *Shop Management*, pp. 112, 113.

[2] Gilbreth, F. B. and L. M., *Applied Motion Study*.

tories; eliminating any of the elements which seemed superfluous, faulty or slow; and collecting into one series the quickest and best elementary movements. The new method of work which resulted from this synthesis was made "standard" and enforced throughout the factory. Their manner was to bribe workers by offers of higher wages to work their fastest while being timed, or in some cases even to time them secretly, using for this purpose a cunningly devised notebook containing a stop-watch. Gilbreth avoided the many possibilities of error which made Taylor's primitive methods most unscientific[1] by using elaborate photographical apparatus —cinematograph and stereochronocyclegraph —but did not escape from the fallacies expressed in the principles underlying this method nor from the mistake of seeking to increase output at all costs, which led to the offer of stimulants to increased production being made at the same time as the new methods were being introduced. The mistakes of the Scientific Management Engineers have been very fully exposed by Professor

[1] Cf. Hoxie, *Scientific Management and Labour*, p. 55 and elsewhere.

Hoxie[1]; by Dr. Myers,[2] who described their methods as "largely empirical or guesswork" and based on "a psychologically unwarrantable and vicious procedure"; by Sir William Ashley[3] and Mr. E. Farmer,[4] and no good purpose would be served by going more deeply into the matter here. It is sufficient to observe that both in method and in manner the Industrial Psychologist condemns as unsound what was, according to Taylor,[5] the very keystone of the arch of his system. Nevertheless he is keenly aware of the enormous waste of human energy involved in the use of inefficient methods, and much careful research into the question of the improvement of methods and the encouragement of the workers to use the new and efficient methods devised is being carried on in this country under the direction of the National Institute of Industrial Psychology. It will perhaps be better if we refrain from quoting (as far as is

[1] Op. cit.

[2] Dr. Myers, *Mind and Work*, p. 26; cf. also "The Efficiency Engineer and the Industrial Psychologist," *N.I.I.P.J.*, pp. 168–172.

[3] *Scientific Management and the Engineering Crisis*, p. 18.

[4] *I.F.R.B. Report*, xiv, p. 34; cf. also "The Economy of Human Effort in Industry," *N.I.I.P.J.*, pp. 18–22.

[5] *Shop Management*, p. 148.

possible) the results obtained by Taylor and Gilbreth, which, although they show what remarkable results may follow changes in the method of performing an operation, do not give sufficient data to allow us to estimate how much of the improvement is due to new motions and how much to other changes, and use instead the carefully checked illustrations given in the Journals of the National Institute of Industrial Psychology and in the Reports of the Industrial Fatigue Research Board.

The general principles followed by the Industrial Psychologists in their investigations of the best methods of applying human energy in different factories seem to be these :

i. The consent, and if possible, the full co-operation of the workers is obtained before any investigation is begun and any changes are made.[1]

ii. No new method of payment or other factor likely to encourage the workers to increase their efforts must be introduced at the same time as a new method of work.[2]

iii. The effect of the change should be judged, not by increase of output, but by decrease in the fatigue of the workers in producing an equal or greater number of units of work. If fatigue is

[1] Cf. Myers, *Mind and Work*, p. 27 ; cf. also *N.I.I.P.J.*, p. 169.

[2] Cf. Eric Farmer, *N.I.I.P.J.*, p. 19.

reduced the output will in time be increased, but if the increase in output is made the object of the change, "what purports to be a scientific investigation degenerates into a process of speeding up."[1] Fatigue can be judged by the shape of the work curve, and to some extent by the subjective feelings of the workers.[2] If output is increased without any encouragement being given to the workers to increase their efforts in any way, it may be assumed that the increase is produced without added fatigue.

iv. The series of motions involved in the operation should be studied as a whole, then each elementary motion should be observed and timed. If great differences are found—as is often the case—between the times taken in doing the same element by different workers, special care must be devoted to finding the cause of the difference and making any improvements which will make the series as a whole more efficient—that is, either more productive or less fatiguing or both.

v. In devising new methods it must not be assumed that a shorter series of movements is necessarily preferable to a longer series. It has been found that "a longer, continuous sweeping movement may prove far less tiring than a series of shorter angular ones, and a slower rhythmical rate may of course be more effective in the end than a faster one." [3]

[1] Eric Farmer, *I.F.R.B. Report*, xiv, p. 34.
[2] Cf. Chapter III, p. 66.
[3] Dr. Myers, *N.I.I.P.J.*, p. 170; cf. also below.

vi. Keeping in mind this question of rhythm, we may still find it possible to eliminate false and unnecessary movements without prejudicially affecting the remaining movements as regards time or difficulty, and so substitute fewer, more efficient, more rapid or less fatiguing movements for comparatively inefficient ones.[1]

vii. One point to notice in this respect is that one of the most fatiguing processes of the mind is that of discrimination which involves close and conscious attention. Therefore, wherever possible, avoid this process by making rhythm the basis of the operation. A rhythmical process is one " which tends to repeat itself without conscious and deliberate effort, because it carries with it a certain affective tone of a pleasant kind, and is not hindered by having to overcome checks." [2] The phenomenon of rhythm will be fully discussed later on in this chapter.

viii. Again, it has been shown that there is less effort needed to lift both hands together than to raise them one after another. If it is possible, therefore, it is advantageous to combine similar movements of the two hands.[3]

ix. Many motions are only made necessary by the relative positions of tools and materials, and can be eliminated by the better arrangement of these accessories, or by the provision of simple apparatus which allows better adjustment of the

[1] Cf. Drever, *The Psychology of Industry*, p. 82.
[2] Eric Farmer, *N.I.I.P.J.*, p. 20.
[3] Dr. Myers, *Mind and Work*, p. 18.

material conditions to the needs of the worker. I am forcibly reminded of Gilbreth's [1] famous illustration of this point, with regard to bricklaying, by the fact that a foreman bricklayer at work on a bungalow, just in front of my window as I write, is engaged in laying bricks on a wall which is now some six feet high. His bricks are in a loose heap at his feet and his mortar board is on the ground near. Every time he needs a brick or some mortar he lowers his body, then raises it loaded through several feet, the nine-pound brick he raises through some six feet to the top of the wall. By introducing an adjustable scaffold, a table to take the mortar box, which was found to be better than a board, and the bricks so arranged that they could be taken up exactly in position for laying; and by a reduction in the other movements involved, Gilbreth increased the number of bricks, which a man could lay apparently without increased fatigue, from 120 to 350 an hour. Much waste of human effort is occasioned by faulty routing, inadequate space, the irregular supply of materials, unsuitable work places, benches, tables, etc., and tools of the wrong size and weight. Where these conditions are outside the worker's control they are also, if badly arranged, a source of constant though unknown irritation to the workers [2]—a psychological state which has been shown to have a deleterious

[1] Cf. Gilbreth's *Applied Motion Study*, quoted Myers, Drever, Taylor, etc.

[2] Cf. "An Investigation into the Tin-Box Industry," Farmer and Brooke, *N.I.I.P.J.*, p. 9.

effect on both the quantity and the quality of the output.[1]

x. It must be remembered throughout, that owing to the great differences in physical build and strength, age, habits, psychological qualities[2] and character, which exist between individuals, it is highly improbable that any one method, however good, will be the best for all persons.[3] Therefore, there must be no attempt to force every one into a common mould, as it were—the worker should be free to affect any method which he finds to be as effective as the "standard."

The application of these principles and the value of the results obtained can best be seen from a few illustrations.

On investigation into the Tin Box Industry,[4] an occupation consisting mainly of repetitive work on presses of various kinds, many adjustments were found necessary to save unnecessary fatigue and wasted movements. It was found that the size of the sheets of metal supplied affected fatigue and output.

[1] Cf. "An Investigation into Breakage Problems," Miles and Eyre, *N.I.I.P.J.*, pp. 137, 138 and 139.

[2] Cf. Chapter II.

[3] Cf. Myers, *N.I.I.P.J.*, pp. 168–9, ". . . harmful . . . and . . . impossible to achieve because no two individuals can be trained to precisely the same features of rhythm and movement." Cf. also *Mind and Work*, p. 22.

[4] *N.I.I.P.J.*, pp. 9–11.

When the optimal size of sheet for each process was ascertained and sheets of that size supplied, the work was so greatly facilitated that output was increased as much as 34 to 39 per cent. The lids, which were stamped out by certain presses, collected on top of the press, were swept off into a box on the floor, which soon was overfull and so fell on to the floor. Seventy-four minutes per worker each day was spent in collecting these lids from the floor, but a simple device obviated much needless stooping and enabled the collection to be made in ten minutes. The tin plates were kept at the side of the presses and had to be lifted to the level of the top of the press. In the case of the heavy presses girls complained that this tired their arms. Boxes were arranged so that the sheets were level with the top of the press. A saving of 9 per cent in time resulted, and the girls said that their arms no longer ached with fatigue.

A very careful study was made of the process of packing chocolates.[1] Each element was timed and examined, and it was found that much time was wasted in discriminating

[1] "An Investigation into the Packing of Chocolates," *N.I.I.P.J.*, pp. 12–17.

between different chocolates and " endeavouring to overcome mental states of indecision by voluntary effort." This was largely due to the haphazard method of arranging the chocolates made necessary by the type of bench. A new type of bench was introduced which allowed of the arrangement of the chocolates, so that the work depended rather on the rhythm of the movement than on a series of voluntary decisions as before. No other alteration was made, but the girls were encouraged to use both hands together instead of one at a time. Five packers used the new bench for four days each. The average increase in output was 35·69 per cent, the highest 53·03 per cent. The averages for the four days were 168, 188, 189, 191, figures which show an obvious practice effect, so that further increases in output would be expected with practice and adaptation. The hourly output curves showing the old and new methods are very instructive. Under the old method the curves rose during the morning, fell off after the lunch hour, and from 4.30 to 5.0 fell very rapidly indeed. Under the new method the whole curve is at a higher level; the morning increase is more marked,

but the rapid fall in the afternoon showing the development of fatigue is completely absent.

A repetitive process in a sweet factory which took on the average two seconds was found to involve three stoppages and three changes of direction.[1] By introducing a continuous curved movement instead of a discontinuous angular one, the time was reduced and the output was increased by 27 per cent, although the actual line followed by the hand was slightly longer.

In the case of girls engaged in metal polishing it was found that in the morning they made fewer movements with less effort and greater speed to accomplish the same results. This suggests that when fresh the worker performs the operation "with a natural rhythm and dexterity which enables her to maintain a high output with comparatively little effort."[2]

In the clothing industry in U.S.A. experts

[1] Cf. Eric Farmer, *The Economy of Human Effort in Industry*, *ibid.*, pp. 18–22; and cf. also *I.F.R.B. Report*, xiv, pp. 39–40.

[2] *Ibid.*, cf. also Bernard Shaw, *Cashel Byron's Profession*. Cashel Byron's lecture in the *salon* of Mrs. Hoskyn, and his demonstration that "ease and strength, effort and weakness" go together.

reported that 45 per cent of the work of "finish pressers" was unnecessary, and the methods of some of these were only 57 per cent as effective as the best methods in use.[1]

The phenomenon of rhythm has been referred to several times, and indeed would seem to be of the greatest importance in finding the best method of doing any repetitive operation. So far there would seem to be no complete psychological explanation of its effects, but it is probably due to several different phenomena which are involved. The first is due to the fact that if a muscular or mental act A is frequently followed by the act B, then the performance of act A will tend to produce at least a readiness in the human system to perform the act B. If an attempt is then made to follow act A by act C, "interference" is set up: act C is impeded by the preparedness of the system to do act B. If A is usually followed by B but sometimes by C, there will be a loss of facilitation in doing act B and interference with the performance

[1] *Waste in Industry*, by the Committee on the Elimination and Waste in Industry of the Federation of the American Engineering Societies, p. 109.

of act C.[1] Furthermore, rhythm has an emotional effect and lessens strain and fatigue by making voluntary attention less necessary and relieving monotony, which is purely a subjective feeling. In this way work is facilitated and made more pleasant.

The explanation of the facilitation effected by rhythmic action may be physiological. It may be that a slower, rhythmic movement allows more complete recovery from fatigue, as in the case of the heart which beats for many years normally without any accumulation of fatigue, and so enables the movement to be repeated more times during the day.[2] It might also be suggested that certain natural sequences involve actions which may appear useless, but which allow the muscles to work freely. To give an extreme example as an illustration, if the fist is clenched with the thumb inside it and pressed hard under the armpit, then the hand is unclenched and the thumb moved outwards, it is with many people a physiological impossibility to reclench the fist with the thumb inside without first withdrawing the fist from under the arm-

[1] Cf. Drever, op. cit., p. 83.
[2] Cf. Chapter III, p. 71.

pit. This movement of withdrawal might appear useless, but to eliminate it would be to make the action of moving the thumb in and out of the hand impossible or only possible with very rapid development of local fatigue. This may serve to illustrate a general principle that there are sequences which must be respected—natural rhythms which enable the muscles to work freely and naturally and without undue fatigue. To disturb these, as might be done by one who wanted to get greater speed by eliminating all apparently unnecessary movements without regard to their physiological significance, might make the movement quicker as a single act, but cause a rapid development of fatigue.[1]

The results of encouraging girls engaged in chocolate covering to use a rhythmic in place of a jerky movement was not only to save time in the performance of the operation, but also to make the new movements so easy that

[1] This point is important as it destroys the idea of general synthesis of new movements from the elements of entirely different movements, which led Taylor to suggest "Handbooks of elementary times comparable to Engineering Handbooks," and Gilbreth to suggest International Exchanges of standard times. I submitted this point to Dr. Myers, who expressed his entire agreement. (Letter dated March 21, 1923.)

the girls were at first reluctant to adopt them as " they felt that by so doing they could not be working as hard as they ought to."[1]

In an investigation in a coal mine the miners' confidence was won by the investigators,[2] and they readily consented to be taught a new method of swinging their picks. The new method was the substitution of a slower, continuous rhythmic movement in getting coal to allow time for withdrawal from the soft coal in which the pick tends to stick and to save energy needlessly expended in checking the upward stroke and in regaining momentum for the downward stroke. The comparative output for ten weeks under the old method and ten weeks—including the learning period—under the new showed an improvement of 10·4 per cent in daily output. As this does not allow for practice effects and the difficulty that would result in the case of these men long used to the old method from habit interference, and taking into account

[1] *I.F.R.B. Report*, xiv, pp. 44–45.

[2] E. Farmer, S. Addams and A. Stephenson, " An Investigation in a Coal Mine," *N.I.I.P.J.*, pp. 125–131. N.B.—The under-manager said the place worked in during the second period was harder than that worked in during the first.

also the small proportion of the day which is spent in using the pick—this result is very remarkable indeed. If young workers who had not the old, less efficient habits were taught the new methods even better results might be expected.

Several psychological problems are raised by the question of training workers in the new and better methods and by the general question of the adequate training of new workers. If a wrong movement is learned it tends to retard and impede the learning of a better method. It would appear wise, therefore, to teach the new method from the start to avoid loss of efficiency due to the intrusion of the old habits. It is often easier to teach a novice a new method than to teach one skilled in the old method—hence perhaps the dislike of old skilled workers to such changes.[1]

The distribution of repetitions is important. Tests have shown that ten minutes' practice a day for six days gives 100 per cent more skill than two hours' practice at one sitting.[1] The process of memorising has been shown to

[1] Cf. Drever, *The Psychology of Industry*, p. 87; cf. also T. H. Pear, *Industrial Administration*, p. 46.

[1] *Ibid.*, p. 89.

be more easy in many cases if the operation is repeated as a whole rather than if each element is practised separately.[1] Too rapid progress in learning may defeat its own end as the learning curve is shown to rise in a series of plateaux, so that in learning a complex process the lower co-ordinations must become automatic before attempts are made to practise the higher—otherwise interference occurs between the two sets of habits.[2]

Gilbreth has claimed that the stereochronocyclegraph shows that fast motions follow a different path from slow motions.[3] In that case, when an instructor tries to demonstrate a method slowly there is danger that his movements will not be those he uses when working at best speed.[4] It may be necessary to encourage workers to aim at the right method at the right speed rather than, as is more usual at present, aiming at quality and hoping speed will follow in due course.

The importance of correct training was

[1] Cf. Muscio, *Lectures on Industrial Psychology*, p. 14.

[2] Drever, op. cit., pp. 90, 91.

[3] Gilbreth, *Applied Motion Study;* cf. also Myers, *Mind and Work*, p. 26.

[4] Cf. difficulties mentioned by E. Farmer, *N.I.I.P.J.*, p. 74. "The more skilled (a worker) is the less he knows what he does."

illustrated in an investigation into the packing of chocolates. Five backward workers were given a three weeks' course, during which they were taught to arrange their materials systematically and to use both hands in a rhythmic easy manner. Before instruction their time for packing four dozen half-pound boxes of chocolates varied from 232 to 429 minutes. The instructor took 156 minutes. The average increase in efficiency was 27 per cent—the greatest increase 37 per cent. The times taken now varied from 195 to 273 minutes. This increase could not be due to practice effects, as the test of four dozen half-pound boxes of X-chocolates was performed only three times.[1]

When new girls were given systematic training on entering the packing-room, instead of picking up the work in the usual way under the supervision of a very busy inspector, they showed themselves to be 26 per cent. more efficient in their fourth week than were girls trained in the ordinary way in their fifth week. The advantages of such a training school are that the new workers attain quickly a good standard of efficiency and can therefore

[1] E. Farmer and A. B. B. Eyre, *N.I.I.P.J.*, pp. 68–75.

earn a good wage more quickly, and that it shows at once if a girl is totally unfitted for the work. If so, she leaves that work without having wasted perhaps a year or two during which she might have learned a more suitable process.

Motion study has therefore the additional advantage of increasing the transferability of skill—an advantage which may if abused bring overwhelmingly greater disadvantages in its train. It is an advantage to which the American Efficiency Engineers gave tremendous importance[1] and which, more perhaps than any other result of their system, aroused the violent and perfectly natural antagonism of organised labour. The present system, governed predominantly by the doctrine of *laissez-faire* (Huxley's "Anarchy plus the constable"), has resulted in this country in the development of an oft-times bitter struggle between employers organised in their industrial groups and workers organised either on the basis of craft or of industry. The power of the employers rests in their ownership of

[1] Cf. Taylor, *Shop Management*, pp. 28, 105, 106; and cf. also Sir Wm. Ashley, op. cit., pp. 20–27, and Gilbreth, *Applied Motion Study*, p. 82.

all the material requisites of industry, and their position is strengthened by the fact that, although in the long run they have as great need of the men as the men have of them, "their need is not so immediate."[1] The strength of the workers depends entirely on their monopoly of the skill in case of craft unions, the labour power in case of General Workers' Unions, necessary to operate the machines and use the materials of the employers. The effects of facilitating the transfer of skill are:

i. New workers can rapidly be trained to take the place of those who do not accept the employers' conditions.

ii. Movement study has shown remarkable resemblances between specialised processes in widely different industries[2] which will enable the workers in these different branches to replace one another. In this way the barriers between different crafts, on which the strength of Craft Unionism depends, will be broken down, and those Unions will be in a weaker position in bargaining for wages and conditions of labour.

iii. The tendency to replace skilled men by less

[1] Adam Smith, *Wealth of Nations*, Book I, Chapter VIII.

[2] Gilbreth, *Applied Motion Study*; T. H. Pear, *Industrial Administration*, p. 46.

skilled, already strongly marked owing to the war-time introduction of "fool-proof" machines, tended by unskilled workers—often low-paid girls and women—is still further strengthened, for by the facilitation of the transfer of the skill necessary for specialised processes to unskilled workers the possibility of increasingly replacing highly paid skilled men by lower-paid semi-skilled men is increased. Although, as Sir Wm. Ashley has clearly shown,[1] some of the skilled men will get even more skilled positions, many of them will have to accept the same wages as the semi-skilled men who will now compete with them. There seems to me no guarantee that the semi-skilled workers will get higher wages than they get now as unskilled workers —the competition, both actual and potential, is too great, and their comparative lack of organisation makes it difficult for them to maintain any standard which they may be given temporarily to encourage them to adopt the new methods.[2] Once the new methods are generally adopted, the need for such special inducement will no longer exist, and long and bitter experience has shown that in that case it will no longer be offered.

"If experts, appointed solely by the employers, are to go round the factory, observing, codifying and standardising the most efficient

[1] *Scientific Management and the Engineering Situation*, pp. 24–26.

[2] Cf. Muscio, op. cit., p. 270 and elsewhere; and cf. also J. A. Hobson, *Work and Wealth*, p. 216.

methods of carrying out different operations, the worker will be robbed, so he suspects, of his craft skill, and will come to be treated, so he imagines, as a piece of machinery."[1] This would . . . "encourage the workers' only too natural belief that the management seeks for its own benefit to deprive him of the craft knowledge, that sole possession which he and his forbears have acquired for generations past."[2]

Before the workers, whose consent is essential to the success of motion study, will agree to it being generally practised it seems that several changes will be necessary in our economic organisation.

First of all there will have to be a great movement towards amalgamation between the different craft unions so as to form Industrial Unions, and ultimately the One Big Union advocated by G. D. H. Cole[3] and others for many years now. This will replace a monopoly based on skill by one based on labour power and so tend to keep the respective bargaining power of "Capital" and Labour

[1] Myers, *N.I.I.P.J.*, p. 169.
[2] *Ibid.*, p. 169.
[3] Cf. weekly articles by G. D. H. Cole in the *New Leader*, also numerous pamphlets and speeches.

in relatively equal positions. The unions must also be strengthened by including as far as possible all the workers available—this would tend to balance the tremendous increase in power which motion study unscrupulously used will give the employer.[1]

The experts who make the motion studies and the records of their investigations will have to be put under the joint control of the employers and the workers. In one case already the Works Committee appointed a special committee to decide under what conditions an investigation should be allowed.[2] It may be that the Trade Unions will have to employ their own experts in these matters as they do in rate fixing in certain industries.[3]

In the case of industries where labour is not sufficiently organised, Trade Boards or their equivalents with power to enforce contracts at law will have to make such provisions with respect to present and future rates and give such guarantees with respect to employment[4] or unemployment pay that no worker shall

[1] Cf. Hoxie, *Scientific Management and Labour*, p. 130.
[2] Rowntree's Works, York, see *N.I.I.P.J.*, p. 51.
[3] Cotton Industry, Coal Mining, etc., cf. *Lectures on Commerce*, II.
[4] Cf. Chapter V, p. 148.

suffer through unemployment or lower wages through no fault of his own. These conditions and safeguards may seem far-reaching in their effects on industry, but they are in line with the tendencies of industrial evolution. The increased security of the workers would be amply paid for by the increase in the national wealth which would result from this one application of scientific knowledge to industry, and there would still be a surplus which could go to increase the dividends of shareholders and others for so long as the present inequitable and unscientific system of distribution of wealth[1] is deemed desirable or necessary.

Mention has already been made of the necessity for the proper organisation of workshops and factories to save loss of time due to faulty routing. This question is of a technical, administrative nature and does not involve especially psychological factors. There are, however, a series of considerations with regard to the adaptation of material conditions to the needs of the workers which do involve psychological and physiological factors of great importance. I refer to the questions

[1] Cf. Clay, *Economics for the General Reader*, pp. 429–446.

of ventilation, illumination, distractions, safety and "welfare." The temperature, humidity and rate of movement of the air has very important effects upon the rate and quality of output.[1] Recent researches[2] have shown that the ill effects of inadequate ventilation do not result from chemical impurities in the air or lack of oxygen,[3] as was widely believed, but from the physical qualities of close air—the lack of adequate cooling and evaporative powers—and from the spread of infection from carriers of disease germs. The cooling powers of the air depend on its temperature, degree of saturation and rate of motion. Normally the human body needs cooling to keep it at about blood heat. This is brought about by loss of heat by convection and radiation from the skin, by evaporation from the respiratory membrane by breathing and by loss of heat used to warm the breath. When the cooling powers of the air are insufficient to keep down the body heat the

[1] Cf. Gilbreth, *Fatigue Study*; Drever, op. cit., Chapter IX.

[2] Especially those of Dr. Leonard Hill; cf. *Industrial Administration*, pp. 99–133.

[3] Dr. Hill says the concentration of oxygen is never reduced in a crowded room to the same extent as in many mountain health resorts.

emergency method of sweating is resorted to —every grain of sweat carries away 580 calories of heat. This process needs glandular secretion and a greatly increased flow of blood to the skin, thus incurring a great increase in the expenditure of nervous energy and extra work by the heart, which has to beat more quickly to drive the blood to the skin. This extra expenditure of nervous energy gives rise to the rapid development of fatigue. Much of the ill-health which causes gigantic economic loss can be traced to infection facilitated by over-fatigue due to the wrong atmospheric environment of workshops, factories and offices. The Kata-Thermometer — an instrument specially designed to measure the cooling powers of the air—shows that the cooling power in centrally heated offices and factories in England is often less than that of the air out of doors in Sierra Leone, Madras or Ceylon—countries notorious for humid heat. The cooling power of the air increases with the rate at which it is moving ; it is therefore advisable to ensure a good supply of cool, dry air constantly in motion. Cool surroundings are of the utmost importance to stimulate men to work. The

New York Commission on Ventilation [1] found that 63 per cent more typing was done by the same workers under otherwise identical conditions at a temperature of 68° F. than at 75° F. In the case of heavy, physical work 15 per cent more was done at 68° F. than at 75° F., and 37 per cent more than at 86° F. The average record of the temperature of the workrooms examined in New York was 73° F., while 29 per cent were over 80° F. The loss of efficiency must therefore have been enormous.

Dr. Myers[2] gives the following figures, showing that as temperature and humidity increase, efficiency decreases. If at 69° F. 52 per cent humidity, efficiency is taken as 100, then at 75° F., 70 per cent humidity, it will be 85, and at 91° F. and 90 per cent humidity only 76.

Dr. Vernon calculated that in the Tin Plate industry 12 per cent more output could be obtained by efficient ventilation.[3]

In the Tin Box industry[4] deleterious dis-

[1] Dr. Hill, *Business Administration*, p. 112; also cf. Drever, op. cit., Chapter IX. [2] *Mind and Work*, p. 68.
[3] Quoted Myers, op. cit., p. 68.
[4] Cf. "An Investigation into the Tin-Box Industry," *N.I.I.P.J.*, p. 11.

comfort was caused in the soldering department by the heat, due to each worker having a Bunsen burner for heating his iron. By introducing screens to shield the burners and better ventilation the temperature of the workers' faces was reduced 5° F., with the result that they could work with far less effort. As a result of his investigations, Dr. Hill is of opinion that "it will pay a thousandfold to employ a specially trained assistant to regulate the temperature and ventilation of factories." "Every effort should be made," he suggests, "to secure the highest level of cooling power which the workers can be brought to stand."[1]

In regulating the illumination of workrooms both the intensity and the distribution of light must be considered. Myers[2] says that in a certain factory, although no other change was made, when the lighting was increased from 4000 to 12,000 foot-candles the output increased by the end of a month from 8 to 27 per cent.

Badly distributed light, which gives rise to glare directly or through reflection in highly

[1] *Industrial Administration*, p. 132.
[2] Op. cit., p. 67.

polished surfaces, causes serious overstrain.[1] A bright object, such as an electric light or its reflection, near the margin of vision, tends to draw the attention and the eye towards it. This instinctive tendency to bring the object into the direct line of vision is only prevented by the constant effort of the antagonistic muscles.

The strain which follows the effort to keep the eyes on the work in front results in the earlier onset of fatigue. There is also an instinctive tendency to focus the eye on the bright object in the marginal field, and additional eyestrain is caused by the effort needed to keep the right focus. As the margin of the retina is more sensitive to light than the centre, a bright light in the marginal field, when the centre is adjusted for less light, produces an uncomfortable glare. For these reasons the uniformity of illumination will be seen to be as important as its intensity. Diffused lighting has been found to improve visual acuity and to prevent the distraction, discomfort and at times permanent injury which result from glare. It has been found advisable to paint highly polished surfaces

[1] Drever, op. cit., Chapter IX.

with a dull black paint such as is used on the inside of cameras.[1]

In a recent investigation in a coal mine scientific work on the question of illumination carried out in the laboratory was combined with that carried out in the mine. By increasing the power of the lamp used and by placing it so that the light was diffused (this was found to prevent "after images") an increase in output of 14·5 per cent was obtained and the amount of dirt sent up with the coal decreased 22 per cent.[2]

The psychological effect of noise and vibration has been found to be a lowering of the efficiency of the worker.[3] This has been most noticeable when there has been a conscious battle against the distractions, but even when there is adaptation to the distraction the best work can usually be performed under the most restful conditions. A 25 per cent increase in output resulted from the removal of

[1] Cf. Gilbreth, *Fatigue Study*, p. 79.

[2] "An Investigation in a Coal Mine," Part II, *N.I.I.P.J.*, pp. 173–181. Important discoveries were also made on the effect of "after images" and deficient lighting as a cause of miner's nystagmus.

[3] Cf. Myers, op. cit., p. 67; and Drever, op. cit., Chapter IX.

certain workers to a quieter part of the works. Münsterburg points out that " strong rhythmical sounds, such as heavy hammer blows which dominate the continuous noises," cause more serious distraction than continuous noises. Where the rhythm is different from that of the work being performed a struggle ensues which causes the expenditure of nervous energy in excess of that required by the work itself.

Similar results are brought about by fear of accidents, a very powerful distraction which tends to produce overstrain.[1] This fear may often be unconscious owing to the apparent accommodation of the mind to the danger, but even so its effect is to decrease both the quantity and the quality of the output. Dangers should be effectively guarded so as to be safe even for tired or unexperienced workers. Such measures will be found to be economically profitable, even if common humanity is not a sufficient motive for introducing them. The same thing is true of what is known as " welfare work "—if it be introduced in the right spirit. " Output in regard to quality, amount and speed is largely

[1] Drever, op. cit., Chapter IX.

dependent upon the food of the workers,"[1] and the provision of suitable canteens, restaurants, rest rooms, lavatory accommodation, etc., has been shown to be profitable, as the expense is made good by the better time-keeping, and higher average output made possible by good health and freedom from fatigue, and by the reduction of labour turnover because no one wants to leave.[2]

By due attention to the method in which an operation is performed, and to the material conditions under which it is performed, the material wealth of the country can be increased without addition to the "human costs" of production, a consummation greatly to be desired.

[1] *Industrial Efficiency and Fatigue*, p. 104.

[2] Cf. Sidney Webb, *The Works Manager of To-day*, pp. 138–152; cf. also Rowntree, *Industrial Administration*, pp. 18, 19 and 20.

CHAPTER V

VARIOUS PSYCHOLOGICAL FACTORS AFFECTING INDUSTRY

THE main questions with which the Industrial Psychologist has to deal may be divided into two broad classes—those such as Vocational Selection, Fatigue and Motion Study, which are open to experimental investigation; and those which approach rather the sphere of Social Psychology—questions of instincts and motives in industry, the psychological reactions to different incentives to work, the effect on industry of fear, suspicion, "the consciousness of kind," the creative instinct, the complex forces which affect industry most noticeably through their cumulative effects, as expressed in a greater or less degree of "Industrial Unrest."

Owing to the immense difficulties in the way of experimentation our knowledge of this second group is at present inadequate

and in some respects almost insignificant,[1] but the problems presented are of no less importance from the viewpoint of the attainment of maximum production than the more simple problems with which we have already dealt. Foremost among these problems in practical significance is the question of reactions to different incentives to action on the part of individuals of different age, sex and character. With this question, therefore, we shall deal first.

The Health of Munition Workers Committee[2] reported that "of all the varied influences affecting the health and efficiency of munition workers, the Committee have found that of incentives to work the most intricate and difficult to investigate. Nevertheless, the subject is of such immediate importance as to demand consideration." It would seem that there is a natural inclination in man to work rather than to be completely idle, but the direction of his activities and the interest, energy and application with which he works are determined by the different forms and amounts of incentive which are offered by

[1] Cf. Drever, op. cit., p. 51.
[2] Cf. *Industrial Efficiency and Fatigue*, p. 69.

different kinds of activity. The most important incentive is the necessity to earn a livelihood, and in the modern industrial system this is bound up in the vast majority of cases with the question of wages—so much so that the American Efficiency Engineers were wont to consider them as the main incentive to production, and devised elaborate schemes of payment which on this assumption would induce the worker to give his best.[1] The result of their systems was, as a rule, the harmful "speeding up" of the workers. Muscio[2] has defined "speeding up" as "the attempt, by offering incentives of one kind or another to the will, to induce operatives to expend more than the greatest reasonable amount of energy in a given time." This has invariably led to complaints from the workers of the undue strain that is put on them.[3] It is necessary, therefore, briefly to consider the different wage systems most commonly in force from the point of view of the different psychological effects which they have on the workers.

[1] Cf. Dr. Myers, "The Efficiency Engineer and the Industrial Psychologist," *N.I.I.P.J.*, p. 171.

[2] Op. cit., p. 35.

[3] Cf. Eric Farmer, "The Economy of Human Effort in Industry," *N.I.I.P.J.*, p. 18.

It seems possible broadly to distinguish between two methods of remuneration—the first payment for the time during which the operatives are at work—time wages paid by the hour, the day or the week; the second payment for the amount of work which is done—piece rates paid by the ton, the piece or other unit of measurement. The distinction is by no means absolute, as each time wage is fixed with reference to a certain standard of output, while piece rates are set with reference to the amount the worker will be able to earn in a given time.[1] The difficulty of comparing these different systems is added to by the facts that "atmosphere seems of far greater importance than the system of payment in vogue,"[2] that the amount of payment is by no means the sole incentive to produce, and that the strength of the incentive does not vary directly with the amount of payment.

The advantages of payment for the time during which the operative is at work are that it is easy to apply, covers time lost through no fault of the worker—a frequent source of

[1] Cf. Schloss, *Methods of Remuneration*.
[2] Myers, *Mind and Work*, p. 152.

injustice in other systems—lends itself to the fixing of standard wages by collective bargaining and tends to produce good quality in the output and good time-keeping. Its greatest advantage is that it removes from the worker an element of uncertainty as to the amount of his earnings—" an uncertainty which, especially in the case of juvenile and female labour, may create a nervous anxiety detrimental to sustained effort."[1] The most responsible workers—managers, accountants and leading officials in general—are usually paid a time wage, as are also workers in trades where output is difficult to measure or where quality is of greater importance than quantity in the work done—University professors, teachers and certain craftsmen. The chief drawbacks to the system are that it gives no direct incentives in itself to special behaviour, that where the " atmosphere " is not good it involves close supervision, which tends to create distrust between the management and the workers, and that unless other interests

[1] *Industrial Efficiency and Fatigue*, p. 70.

N.B.—I am indebted for material for this discussion to Dr. Myers, especially Chapter V, *Mind and Work*; Sir Wm. Ashley, *Lectures on Commerce*, II; Dr. Drever, op. cit.; and J. A. Hobson, *Work and Wealth*.

are fostered it tends to mediocre standards of output. However, " the good results attained by payment by time indicate that, given suitable environment, the inclination to work is a deep-seated, natural phenomenon, and it is questionable whether in the end the best results may not be obtainable by following the principle of a ' good day's work for a good day's pay ' with reasonable good faith on the part of both employers and workers."[1]

Piecework gives a more direct and, when well adjusted, a far more powerful stimulus to this natural inclination to work. Especially is this so in repetitive work, which would become monotonous but for the interest developed by payment by the piece. For example, girls on the monotonous, repetitive work of drilling fuses increased their output by 24 per cent on the day shift and 40 per cent on the night shift when changed from day wages to piecework, while girls retapping fuses by hand increased their output by 28 per cent by day and 48 per cent by night after the same change.[2] It gives special awards for different degrees of skill and application, and

[1] *Industrial Efficiency and Fatigue*, p. 70.
[2] *Ibid.*, p. 71.

so removes the sense of injustice which may be caused where a man does half as much work again as his neighbour for the same pay. Under right conditions it may lead to friendly rivalry which may have good results on the total output. The problem is to arrange that the incentive shall be strong enough to encourage the maximum production but without causing over-speeding. Dr. Vernon[1] found that the danger of over-speeding was by no means negligible and led frequently to breakdowns and ill-health. There is a danger, too, that piece rates will lead to neglect of quality and so cause wastage of material or costly and irksome supervision. Certain psychological questions arise under a piece-rate system more acutely than under a day-wage system.

i. The piece-rate system must be fully understood. When the payment is made on a group output basis, or in any way which may not be obvious to the workers, it must be carefully explained. "Mistrust, discontent and misunderstanding are frequent among employees, who imagine that they are being exploited, when, as not infrequently happens, they are unable to estimate for themselves their exact earnings,"[2] and in this

[1] *Industrial Efficiency and Fatigue*, p. 75.
[2] Captain Agnew's report, *ibid.*, p. 71.

way that "atmosphere," which is all-important if maximum output is desired, is destroyed.

ii. The system must be properly adjusted. For example, a firm which paid a day wage to learners until they reached a speed at which they could earn more by piecework, raised the day wage and at the same time the limit at which the piece rate came into operation. As a result very few of the workers were able to reach this level, and even then got only a slight additional wage, so that the remainder made little effort to reach it at all, and the incentive did not operate.[1] Similarly, if unskilled men are able to earn far greater wages than highly skilled men, as was the case during the war, the skilled men are dissatisfied, and tend to take less interest in their work, keep bad time and generally lose in efficiency.[2]

iii. A piece-rate system is sometimes used—not always intentionally so, but in effect—so as to avoid collective bargaining. Very often the piece rate is fixed by the foreman, and as even the principle of "mutuality" does not allow of the verification of rates by Trades Union officials, this is in effect a reversion to individual bargaining.[3] To remedy this defect some such arrangement as is common in the cotton industry, where piece rates are fixed by collective bargaining, and verified by the Union Officials, is necessary when a piece-rate system is introduced.

[1] *Industrial Efficiency and Fatigue*, p. 75.

[2] Cf. *ibid.*, p. 74.

[3] Cf. Webb, *The Works Manager of To-day*, pp. 55–98, see p. 63.

iv. The gravest risk of a piece-rate system, and one which has discredited the system so much that certain Unions refuse to entertain the suggestion of adopting piece rates, is that the rates will be cut whenever a worker gets more than what the employer thinks to be a " reasonable " wage. One foreman is reported to have said in 1915, " What can one do when a girl is earning as much as fifteen shillings a week, but lower the piece rate ? " [1] Even when the piece rates are not openly cut they are often lowered secretly by substituting one man for another at a different rate, by making slight alterations in processes, and lowering rates more than proportionately to the saving in time which the new method allows, and so in innumerable ways it has been proved to the workers that, however hard they work, they will never be allowed to earn more than a certain amount. The difficulty thus created led the American Efficiency Engineers, who were among the first strongly to condemn the practice of rate cutting, and many of the better employers, who realised the danger of the policy, to devise intricate systems of payment which would, they hoped, render the practice unnecessary. Among the workers it was one of the greatest causes of " Restriction of Output."

The need for some system which avoided the necessity of rate-cutting and yet prevented the earning of " unreasonably " high wages seemed, from the employer's point of

[1] *The Works Manager of To-day*, pp. 69, 70.

view, very strong. It was found that some men are unable to make satisfactory use of high wages as they have not developed the saving instinct, and so when once their usual level of comfort is reached they spend any extra extravagantly and work shorter hours in order to have time in which to enjoy it.[1] Their efficiency was lessened and their time-keeping became bad—as Taylor said, "It doesn't do for most men to get rich too quickly."[2] Taylor went so far as to say that there was an amount of increase which in different classes of industry was exactly sufficient to induce maximum effort in men whose strength, valuation of money, etc., were widely different, just as it is possible scientifically to determine the exact amount of spirit needed to make an internal combustion engine of a certain power, size and stroke of cylinder, and so on, perform a given number of revolutions in a given time. Although British employers have never consciously adopted this attitude they have used this difficulty, due largely to lack of education of the workers, to rationalise their action in taking to themselves as extra

[1] *Industrial Efficiency and Fatigue*, p. 74.
[2] Cf. Taylor, *Shop Management*, p. 27.

profits what under a straight piece-rate system would have given the worker higher wages. For this there can be no excuse, for the demand of the workers for a greater share in the product of their labour does not necessarily mean higher wages, but may be granted in extended schemes for insurance against unemployment and ill-health, in making provision for workers' pensions, in health, recreation and education-giving schemes under the control of a workers' committee,[1] and in other ways which add to the well-being of the workers, and are given not as a charity but as the rightful share of the workers in the fruits of their industry—a part of their wages. Moreover, the derogatory meaning now attaching to the words "war profiteer" and "nouveau riche" suggests that the money was no better spent by shareholders and employers than it was by the least educated of the workers.

The schemes evolved to avoid rate-cutting, the Halsey, Rowan and other bonus schemes, for example, have been justly described by Mr. Webb as "Ingenious arithmetical scales for depriving the operative of part of the increased earnings that would be equivalent to

[1] Cf. the Works Councils at Bournville and elsewhere.

the increase in his output . . ." and which try "so to arrange the premium that under no conditions can the workman so far reduce his time as to tempt the employer to cut the rates." Even in this, however, they have been found to fail, for the psychological effect of these schemes, of which the essential element is a device by which the rate per piece is automatically cut as the time taken per piece is reduced, on the rate-setters has been found to be a tendency to carelessness in the fixing of the standard time which has led to difficulties so great as to cause many firms to abandon the premium-bonus schemes and resort once more to a straight piece rate. Although there is no inherent justice in the piece-wage system,[1] it is less unjust than these bonus schemes with which it was sought to replace it, and in those industries where it can be introduced without affecting the collective agreement to the wages contract, and is administered with due regard to the psychological and physiological factors involved, it has proved itself the most practicable way of getting men to work as hard as they reasonably can.

[1] Cf. J. A. Hobson, *Work and Wealth*, p. 193.

The question of the "Restriction of Output" must be considered more closely, and since it is more consciously practised in highly organised industries by employers than by the workers it must be considered from the wider viewpoint as well as in its bearings on the question of wages. Among employers[1] output is restricted both consciously and unconsciously from a variety of reasons.

A. Conscious restriction is due chiefly to :

i. In case of a dearth of new materials, output is restricted lest materials should be cornered and excessive prices demanded.[1]

ii. Fear of flooding the markets—overproduction in a very restricted sense, such as resulted from too keen competition, and led to the formation of cartels, trusts and monopolistic combinations with their fixed quotas, fines for overproduction and bonus on underproduction relative to the quota assigned.

iii. When one department has produced more of its products than other departments can use, the output in that department is restricted. So also in the case of large vertical combinations which do not sell largely to outsiders, if one trade overproduces relatively to the others restrictions may be made.

[1] Myers, op. cit., Chapter IV.

B. Unconscious restriction of output by employers:

i. Inefficient management prevents the maximum output being obtained from a plant and the workers engaged in it.

ii. So do overlong hours of work, lack of rest pauses, the selection of workers, foremen, and officials who are not as well suited for their positions as others would be—neglect, in short, of the teachings of Industrial Psychology.

C. Conscious restriction of output by the workers:

i. In the case of a dearth of employment in a particular industry, an attempt is often made to make the work spread over so as to avoid unemployment, and the consequent weakening of bargaining power in making wage contracts.

ii. The workers have learned the evils of glutted markets even more bitterly than the employers, and although they realise the fallacy of the "lump of labour" theory, yet they know from long experience that, at any given moment, the demand for goods of one particular type is limited so that rapidly enlarged production tends to create temporary unemployment in that industry.[1] In the long run they know that increased output per man, will, unless the trade is controlled by a trust which is restricting output and so keeping up price,

[1] Cf. Myers, op. cit., pp. 130, 131; cf. also J. A. Hobson, *The Economics of Unemployment.*

cheapen the goods, enlarge the market for them and so increase finally the total amount of employment in the industry. But in the meanwhile, maybe for a period of years, some of the workers will be unemployed—suffering hunger and degradation, themselves and their families. Security is of more importance to the mass of the workers than a temporary rise in their wages—"restriction of output is based on the psychological need for security." [1]

iii. Fear that piece rates will be cut if wages which the employer considers too large are earned is the greatest cause of conscious restriction of output. Taylor expressed this clearly when he said, "After a workman has had the price per piece of the work he is doing lowered two or three times as a result of his having worked harder and increased his output, he is likely to lose sight entirely of his employer's side of the case, and to become imbued with a grim determination to have no more cuts if 'soldiering' can prevent it." [2] "There is absolutely no economic or ethical justification and no commercial compulsion for a cutting of piece-work rates," [3] for it is not the rate of wages of the workers which matters, but the labour cost per unit of output. The higher the wages earned—that is, the greater the output per machine or work bench—the greater will be the employer's profits, prices remaining the same, owing to the reduction in

[1] J. A. Hobson, *Work and Wealth*, p. 198.
[2] Taylor, *Shop Management*, pp. 34, 35.
[3] Sidney Webb, op. cit., p. 73.

overhead charges per unit of output, and yet experience shows that the piece rates are practically always cut either openly or by more or less secret methods. Mr. Webb has clearly demonstrated the futility of such a policy which invariably leads to the practice of restriction of output.[1]

iv. Restriction of output has also been found to occur when the system of payment is not properly understood, or is imperfectly adjusted so that there is a sense of discontent or injustice or the incentive is insufficient to encourage greater effort.[2]

D. Unconscious restriction by workers:

i. As was demonstrated in the discussion on the effect of overlong hours on output, much of the restriction of output by the workers is the result of the physiological process of "balancing"—the process of adaptation by which the human organism defends itself from the effects of over-fatigue by an unconscious proportioning of the rate of expenditure of energy to the length of the working day.

ii. A certain amount of restriction of output is due to general slackness, to old customs, to inefficient habits of work, to routine processes which must be adjusted to one another and would be disturbed by an increase in output from one department, and to some extent even to "an irresistible desire of the workers always to work according to a fixed standard," so that, when they find that

[1] *The Works Manager of To-day*, pp. 76–80.
[2] Cf. pp. 143 and 144, above.

they can easily exceed one standard, they proceed to set up another at a higher level.[1]

iii. The effects of fear, suspicion, distrust, general industrial unrest, is so to change the mental attitude of the workers that unconsciously they lose interest in their work and their output falls below its one time level. This is often the result of a reduction of wages—the workers may be discouraged and annoyed, and also deteriorated in strength and endurance, so that their output falls off more than proportionately to the cut in wages.[2] That is also why a system which depends ultimately on sheer force—lock-outs and strikes—for the determination of wages can never hope to achieve maximum production. The psychological effects of a "successful" lock-out are such as to make it at best a pyrrhic victory. Indeed, taking a general survey of the causes of restriction of output, we are bound to conclude "that it is not mere laziness or malice on the part of the workmen; that it is the inevitable result, human nature being what it is, of the general industrial situation."[3]

There are other incentives[4] to work besides those offered by different wage systems, but of these, although their importance may out-

[1] Cf. Dr. Vernon's article, *N.I.I.P.J.*, pp. 182–188.
[2] Cf. Sidney Webb, op. cit., Chapter V, especially p. 53.
[3] Sir Wm. Ashley, op. cit., p. 9.
[4] Cf. *Industrial Efficiency and Fatigue*, pp. 69–78; Myers, op. cit., Chapter V; Drever, op. cit., pp. 47–61; Webb, *The Works Manager of To-day*.

weigh that of any particular method of remuneration, very little accurate knowledge has been obtained. Pride in craftsmanship—the incentive which has produced many of the masterpieces of the arts and innumerable elaborate fretwork ornaments—is of importance, especially in those branches of industry where quality is more to be desired than quantity. Personal rivalry—the spirit which induces the men to give their last ounce of energy to win at football and in other sports—can be of great use in getting men to work with interest and enthusiasm so long as the athletic spirit is not allowed to induce the men to overstrain and so impair their future powers of production. In a similar manner the hope of promotion may be used to encourage interest and enthusiasm in the workers, and it is all-important in this respect that promotion should be by merit and not, as is often the case, influenced by favouritism, relationships and other forms of jobbery.

An interesting experiment was made in a munition factory in the use of " rest " as an incentive. A time was fixed for each job which would allow the work to be done at a

reasonable rate. The workers found that by working more rapidly than usual they could do a job for which thirty-five minutes was allowed in twenty-five minutes, and so earn a rest of ten minutes during which they might smoke and talk. "It was interesting," says the report, "to watch those operatives swing into their labour in order to obtain their rest pause."[1] This idea might be introduced into premium-bonus schemes to prevent over-speeding.

Anything which adds to the interest of the workers in their work acts as an incentive to greater production. Participation in the management of the works, apart from other advantages, has the effect of giving greater interest to a large section of the workers and stimulates them to greater effort. This effect is not, however, universally found. In this connection, too, the effect of better social conditions—shorter hours, better housing, facilities for recreation and for education—has been shown to be very important. The output per head in a works where high wages were paid but no attention was given to social conditions was found to be less satisfactory

[1] *Industrial Efficiency and Fatigue*, p. 76.

than that in a works where wages were considerably lower but careful attention was paid to the health and general social conditions of the workers. "The wages question is intimately bound up with social, economic and hygienic considerations."[1]

An incentive which is far too often employed and of which the results are rarely satisfactory is that of fear. Fear of "the sack" is used by the foreman or even by managers and employers to try to get greater output and the acceptance of worse conditions and lower pay. Taylor introduced fear as a permanent feature in his notorious "differential piece-rate system," which gave high pay for success at the task set, and added to the force of the inducement by fear of loss in case of failure by paying a much lower rate in this eventuality. Further, he maintained[2] that "Workmen quite often have to have the object-lesson of seeing men 'laid off' for failing to earn high wages and others substituted in their places." The effect of fear, however, is often injurious from the viewpoint of maximum output, as there are two opposing

[1] Cf. *Industrial Efficiency and Fatigue*, p. 74.
[2] Cf. *Shop Management*, p. 83.

tendencies bound up with the emotion of fear —the tendency to greater activity due probably to the instinct of flight and the tendency to a greater or less degree of paralysis of movement due to the impulse to concealment.[1] In many people—especially when the fear is prolonged and intense, as in the case of the dread of unemployment in a man with a family to which he is devoted—the second tendency is greater than the first, and though for a time they may be stimulated to greater activity it is only with a disproportionate expenditure of energy and consequently with rapid production of fatigue and impairment of future powers of production.

It will be well at this point briefly to summarise the important psychological factors involved in a consideration of incentives to work, with special reference to wage systems :

i. A healthy environment is the first essential to success—to get a healthy populace to whom a wage system may appeal as an incentive to work. High wages, without provision for a sound social life, is not so effective as less wages paid to workers whose social environment is better. In all cases

[1] Cf. McDougall, *Social Psychology*, pp. 50–53.

"atmosphere" seems to be of greater importance than the system of wage payment.

ii. Other things being equal, an immediate reward has greater incentive value than a more distant one, and a personal incentive is more powerful than a group incentive. Profit-sharing schemes have for these reasons often proved less inducement to increase output than a direct, personal incentive in the form, say, of a straight piece rate.

iii. Similarly the intensity of action is in proportion to the strength of the incentive up to the limit when the motive becomes so overpoweringly strong as to impair the power to work or even make action impossible, as in the case of violent emotion.

iv. Under favourable conditions, e.g. standardised, repetitive work a straight piece wage fixed as far as possible on a basis of collective bargaining is a more powerful incentive than a time wage.

v. It must be remembered, however, that security is of more importance to the majority of the workers, when once they have acquired the minimum necessary to satisfy physical needs, than an increase (which may only be temporary) in their wages. Therefore, "However perfectly scientific a wage system may be, organised labour is compelled by its most essential principle to resist any wage system which, in its eyes, endangers the solidarity of its combination." [1] This Trade Union solidarity, which Taylor completely failed to understand, is bound

[1] Sir Wm. Ashley, op. cit., p. 16.

up psychologically with the gregarious instinct,[1] which is usually most highly developed among animals liable to the attacks of beasts of prey.

vi. Any wage system should be clearly understood by all the workers; adjusted so as to avoid injustices such as loss by the worker owing to faults in machinery, material, etc., not within his control, or higher pay for less skill and expenditure of effort; so arranged as to give sufficient incentive to increased production; and based as far as possible on joint agreement between organised workers and organised employers, enforced by inspection by experts employed by each side.

vii. Further, to obtain maximum production it is necessary to guarantee (*a*) that rates, once fixed, shall not be lowered unless the conditions are admittedly so changed that the work can be done easier and quicker; (*b*) that no worker shall suffer through unemployment caused through no fault of his own; (*c*) that piece rates should be fixed as the result of Time Study, instead of by tradition and guesswork, which shall be made by experts maintained by each side on the principle that "No one can be trusted to be judge in his own cause."

Before our ideal of the greatest possible production with the least possible expenditure of human energy can be approached

[1] Cf. Sir Wm. Ashley, *The Adjustment of Wages*, p. 12; cf. also McDougall, op. cit., p. 84.

certain problems will have to be dealt with which are so deeply rooted in our economic organisation as to be inaccessible to changes in wage systems which do not fundamentally alter that organisation. These are the problems which can be brought together under the heading " Industrial Unrest." Just as physical overstrain reacts on the mind, lessens control of the higher intellectual processes and allows all the suppressed impulses, cravings, fears and worries of the past to surge into consciousness and prevent that concentration of the attention necessary to efficient work, so also mental states react on the physical, lowering vitality, allowing the earlier approach of fatigue, lessening efficiency in many ways. There is much in the conditions of modern industrial employment which is calculated to produce an atmosphere of unrest, to produce emotions the reactions of which will lessen physical efficiency and check the rate of output. The deleterious effects of fear have already been mentioned. The workers of to-day see much to be feared in the application of science to industry, especially as practised by the American pioneers—the fear of unemployment, temporary no

doubt, but terrible in its effects on the physique, morale and character of the worker and on the home laboriously built up[1]; the fear of overdriving or "speeding up," with consequent ill-health and unhappiness; the fear that the opportunities for promotion will be fewer under the new system[2]; the fear that their Trade Union solidarity will be broken[3]; and justifiable fear that greater opportunities will be given to unscrupulous employers to use the name of science to advance their own ends and gain huge profits compared with an insignificant rise in wages.[4] Unless such safeguards are given to the workers that they will be sure that they will lose neither in payment per unit of effort nor in security, for the present nor in the future, and that they will share in the greater wealth produced, the result of their fear will be either that they will refuse to consent to the new methods being introduced, or being forced to accept them will do so unwillingly and be filled with suspicion which will make full

[1] Cf. Rowntree, *Industrial Administration*, p. 15.

[2] Justified by Hoxie's report, cf. *Scientific Management and Labour*.

[3] Cf. *ibid.*, pp. 123–135, an avowed object of Taylor.

[4] Cf. the examples of Taylor, e.g. shovelling 70 per cent increase of wages, 75,000 dollars increase in profits.

success impossible. The effect of suspicion is a tendency to destroy social intercourse, and the more widespread it becomes the more it paralyses the life of the community which is based on a considerable degree of confidence between its members. Alexander F. Shand, in an article in the *Psychological Journal*,[1] shows that suspicion depends usually upon the suspect being in a position to do harm to the subject and tends to be emotionally strong, other things being equal, in proportion as the evil anticipated concerns the subject himself or those whom he loves. The tendency of "Scientific Management" when introduced, as in U.S.A., without safeguards for the workers was shown to be towards industrial autocracy,[2] which increases the power of the employer to harm the worker and those he loves, and so inevitably gives rise to strong suspicions which destroy the confidence and co-operation needed to obtain the maximum output.

Envy and resentment are feelings which are quite incompatible with that smooth running of the industrial machine necessary for a high

[1] Volume XIII, p. 195.
[2] Cf. Hoxie, *Scientific Management and Labour*, pp. 123–135.

standard of output, but these are feelings which are daily being aroused under the present autocratic system of industrial organisation. Envy is aroused by the ostentatious display of wealth and power, the luxury, the comforts, the magnificent educational opportunities and the fine, large houses of those who take the cream off the produce of industry while Dr. Leonard Hill reports of the workers:[1] "Millions live in tenements in which no breeder would think of raising his stock; in such places are bred and made degenerate the children of this great British Empire." Resentment is aroused by the capricious tyranny to which the workers are still often subjected,[2] and even more so by the huge earnings of absentee directors and shareholders.[3] These feelings are further aggravated in many cases by the knowledge of the workers of the inefficiency of management and of the incompetence of employers and managers who obtain their positions through influence, inheritance or jobbery rather than ability.

None of these evils, which do incalculable

[1] *Industrial Administration*, p. 108.

[2] Cf. Sidney Webb, *The Works Manager of To-day*, p. 27.

[3] Dr. Myers, op. cit., p. 178.

harm even from the viewpoint of maximum efficiency alone, is inherent in the application of psychological science to industry—they are merely consequences of the present system of economic organisation which stand effectively in the way of the Industrial Psychologist. If he is fully to succeed, the "profiteer" who takes "out of an industrial enterprise anything beyond a fair remuneration for personal services actually rendered"[1] will have to be expropriated and the produce of industry more equally distributed among the producers. Mr. Sidney Webb, in his closely reasoned book, *The Works Manager of To-day*, has shown that "We shall never get the maximum production out of our industrial establishments so long as these are run, and are known to the operatives to be run, not for the benefit of the persons who do the work, not even for the benefit of the community as a whole, but for the benefit of a class of functionless landlords and shareholders to whom we have, by the laws that we have made and by the social system that we maintain, chosen to give the privilege of levying a tribute on our labour equal in the

[1] Cf. Sidney Webb, op. cit., p. 155.

aggregate, in the United Kingdom and the United States, to something like one-third of the produce" . . . "so long as we persist in keeping three-fifths of the producers no better than horses (and many of them far worse than horses) whilst ten or twenty thousand 'captains of industry' insist on claiming for their really indispensable services, out of the common product, each of them perhaps fifty or an hundred times as much as the craftsman's standard rate, there will be (as of course there ought to be) industrial unrest."[1] There is need, before the Industrial Psychologist will have a fair chance to apply his knowledge to the service of industry with complete success, of changes in the control of our economic organisation which is now in a form analogous to rule by a landed aristocracy, comparable to the changes which have been made in the political control of this country.[2] In an industrial democracy applying scientific knowledge to the production and distribution of wealth lies the hope of future prosperity for this country.

[1] *The Works Manager of To-Day*, pp. 153–157.
[2] Dr. Myers, op. cit., p. 185.

CHAPTER VI

CONCLUSION

"There is absolutely no conflict of interests as between employers and employed and the general body of the public, so far as health, hours of work, and hours of recreation are concerned. What is bad for one is bad for all." [1]

SEVERAL of the matters with which the Industrial Psychologist deals would indeed seem to leave no grounds for dispute, so beneficial to all classes are their results and so desirable the objects which they seek to bring about. Surely no one can benefit by the deliberate choice of the ill-suited, may be incompetent worker, instead of one who by innate qualities, training and character is fitted for the work to be done. None suffer worse than the workers themselves from the unscientific methods of engaging labour to-day—numerous lives are

[1] Dr. R. M. Wilson, *The Care of Human Machinery*, p. 29, quoted *N.I.I.P.J.*, p. 86.

sacrificed because of the ignorance which allows them to enter an occupation for which they are not fitted—and the economic loss alone is colossal.[1] It is of even greater importance to the employer that he should have suitable, well-trained, efficient workers than that he should have up-to-date, well-constructed, properly lubricated machinery. The first step towards attaining this end must be in the initial selection of suitable learners, selected by an expert psychologist as the result of careful tests, the use of educational reports, medical examination and a personal interview, during which careful observation should be made of those actions, manners and other signs which, to the expert, indicate much concerning the character of the subject. But vocational selection is not enough. While it suffices to tell which of the applicants for a position is in all probability most suited for it, it does not suggest what shall be done with the other applicants, nor is it at all certain that the best fitted for the position in other ways will be content in that position. Vocational guidance becomes necessary so that children can be told what sort of work they

[1] See Chapter II, p. 56.

are most likely to succeed in, what kind of work this is and under what conditions of payment, hours and atmosphere, and with what promise of future advancement the work is performed. The ideals of the youths should as far as possible be discovered and utilised in finding the work for which not only their physical and mental qualities but their desires and interests fit them. In this way great saving will be made by the increase in efficiency and the decrease in accidents, ill-health and discontent among the workers. Even more important is it that this principle of selection by fitness rather than by influence, inheritance or rule of thumb methods should be applied to the higher positions in the administration of industrial concerns.

"Every advance in knowledge, every improvement in scientific technique which makes the lot of the worker easier or affords him a better return for his labour, at once puts money into the pockets of the master."[1] Employers are not likely for long to neglect such opportunities for greater wealth. Where fatigue study is introduced in the right spirit

[1] Dr. Wilson, op. cit., p. 70, quoted *N.I.I.P.J.*, p. 86.

—the true aim being to lessen the fatigue of the workers and enable them to earn higher wages—it will meet with little opposition from the workers so long as their consent is first obtained. Even benefits when forced upon the workers as upon horses or cattle without their consent, may give rise to discontent and do more harm than good. Once again, it seems incredible that anyone should wish operatives to work longer than that length of working day which science shows to be productive of the greatest output. Much saving in efficiency would result from the scientific determination of the best possible working day for each class of work and worker. If—as all indications tend to show it probably would—this proved to be a shorter period than is now worked, what inducement could make either workers or employers insist on the longer hours being worked? In this case the extra opportunities for education, rest and recreation would without doubt have a beneficial effect upon the social outlook of the workers—a tendency to contentment which would be reflected in better relationships all round, smoother working and greater efficiency. Just as Vocational

Selection and Guidance would tend to give more equality of opportunity—without which freedom of enterprise means merely the right of the powerful to oppress the weak—so also would the increased leisure which J. A. Hobson has described as "the opportunity of opportunities"[1] and has shown to be an essential to that education upon which the future of our race depends.

Under this heading of non-controversial points we may include also the careful organisation of the factory so as to minimise the amount of human effort necessary and to give such atmospheric conditions, illumination and freedom from noise, and vibration, as will enable the highest state of efficiency to be maintained.

Due attention to these points alone will so better the conditions of labour (even while adding to the profits of the employers) and so add to the width of their outlook that further progress in the way of the application of psychological knowledge to industry may well be possible. Furthermore, the habit of employing experts and of adopting the scientific rather than the traditional view of

[1] *Work and Wealth*, p. 236.

industry may bring about, in time, among employers, a change of outlook which will enable the gradual elimination of those factors in the present system of industrial organisation which create unrest and stand in the way of the attainment of maximum efficiency. We may hope also for the wider application of science to industrial life. The experience of the trusts has suggested that competition is often wasteful and unscientific, and that organisation to avoid competition may result in cheapening the cost of production of goods. Science may be applied in this broad sense to the organisation of production, so that the new methods of administration and organisation would spread rapidly through a whole industry. At present the danger is that, although sweating, overlong hours and unhealthy conditions of work do not pay in the long run, indeed can never pay from the point of view of Society and the economist, yet they may give large immediate profits to an individual firm. This stands in the way of the universal adoption of scientific, healthful, efficient methods of organisation. We may hope, too, that the applications of scientific methods will not be confined to

questions of production. Even more pressing are the questions of distribution. "No one would think," wrote Taylor, "of using a fine trotter to draw a grocery wagon"[1]; no more should we use a skilled engineer to do work which a trained labourer could do. It is just as wasteful—perhaps more so from the point of view of society, having regard to the economic evils of great inequalities of wealth[2]—to use money at a high rate of interest when it could be obtained at a lower rate, to give huge profits as incentives when far less would suffice to get the same quantity and quality of service, to allow the individual to claim values created by society and often to give the greatest rewards for little or no personal service. The question of incentives should be studied in its broadest sense and in a truly scientific spirit with the object of obtaining for the community all those services necessary to the satisfaction of the wants of the community as regularly and with as little expenditure of human effort as possible. The whole community should get the benefits to be

[1] *Shop Management*, p. 28.

[2] Cf. Clay, *Economics for the General Reader*, p. 429, et suite.

obtained from the applications of science to life—not merely those who have the economic power to acquire them. It will be necessary to decide what functions and services are best left to men under the incentive of profit and with what safeguards to the workers and consumers, and what are best left to men paid salaries and influenced by such incentives as honour and artistic and professional pride. The systematising of the science of management, now largely empyrical, and the facilitation of the transmission of skill by scientific methods of training will make the problem of the control of industry more simple than it is at present, and the creation of a class of Trades Union experts essential to the introduction of the new methods in this country, used to the practice of vocational selection, fatigue study and time and motion study, will facilitate the change from autocratic to democratic control. It is possible also that an accurate knowledge of the approximate quantities of different goods which would be wanted by the community would enable the better co-ordination of production and consumption and lessen—if not eliminate—the evils of unemployment and badly paid short

time.[1] This would tend to add to that economic security which is all-important to the vast masses of the people.

Undoubtedly, by the application of science to life, man would be able, within a comparatively short period, to transform the physical conditions of his existence. What the future will bring forth for mankind is a fascinating speculation upon which many great thinkers from Plato to H. G. Wells have delighted to exercise their faculties; but it scarcely comes within our present scope. Nevertheless, since we began with a quotation from one Utopia we may perhaps end with a sobering reflection from yet another. M. Anatole France in a delightful chapter of his *Sur la Pierre Blanche* shows us one Hippolyte Dufresne transported, in a dream, into the year 2270 and under the collectivist regime of a great Fédération Européene. He there learns that, thanks to Y-rays and Z-rays and the scientific methods in vogue, the struggle for existence is an almost forgotten metaphor; a six-hour working day has glutted Europe with riches, war is inconceivable, the arts and sciences flourish, and life has become full, rich and gracious.

[1] Cf. J. A. Hobson, *The Economics of Unemployment.*

Finally, Hyppolyte asks, "Are you happy ?" His informant, shaking his head, replies :

"Il n'est pas dans la nature humaine de goûter un bonheur parfait. On n'est pas heureux sans effort, et tout effort comporte la fatigue et la souffrance. Nous avons rendu la vie supportable à tous. C'est quelque chose."

A SHORT BIBLIOGRAPHY

THE following list does not profess to be exhaustive, but is intended rather to indicate those books from which the greatest help was obtained by the writer. The classification may need a few words of explanation. As was observed in the opening chapter, some reference to the pioneer work of the " Scientific Management " school of the U.S.A. is essential to the proper understanding of the present economic position of Industrial Psychology in this country. The books given under this heading are but a small selection from the flood of literature with which the American markets were inundated. They are, however, sufficient to give what Taylor was pleased to call the " philosophy " of the movement and the criticisms made on the spot by capable observers.

Under the heading of " Industrial Psychology " are presented the most important of the works published in England which deal

with the problem of the application of science to industry, predominantly from the standpoint of the psychologist and which suggest modifications of the American practice necessary in the light of his special knowledge and of the enormously different conditions of industrial organisation in this country. These works include the reports made by different committees and experts on problems of industrial psychology which became acute during the war and which are specially valuable not only for the mass of reliable statistics on which they are based, but also because of the great opportunities for scientific investigation due to the suspension of all the Trade Union protective practices and the intense interest of all concerned in increased production under the stimulus of patriotic emotion. The very exaggeration of these problems because of the abnormal conditions which prevailed enabled a more accurate and detailed study of the factors involved and added greatly to the value of the reports and the books which present in concise form the results of the investigations therein described.

Between the scientist and the business men

and Trade Union leaders a middleman is necessary whose duty it must be to prepare the goods of the scientist for the consumption of the business community. This function seems most fittingly to be performed by the economist who translates into terms of industrial organisation and concrete business problems the more abstruse discussions of the psychologist and physiologist and shows the relationship of the new discoveries to the past developments and present tendencies of economic life.

A. SCIENTIFIC MANAGEMENT

* Signifies the more essential books.

1.* DR. TAYLOR. The Principles of Scientific Management. The best exposition of the theory of the movement.

2. DR. TAYLOR. Shop Management. A detailed account of the organisation and mechanism by which Scientific Management can be achieved.

3. EMERSON. The Twelve Principles of Efficiency.

4. GANTT. Work, Wages and Profit.

5.* F. B. and L. M. GILBRETH. Applied Motion Study. Introducing "instruments of precision" for measuring motions.

6.* PROF. HOXIE. Scientific Management and Labour.[1] A detailed criticism of both theory and practice.

7. DRURY. Scientific Management: a History and a Criticism.

B. INDUSTRIAL PSYCHOLOGY

1. A. F. STANLEY KENT, M.A., D.Sc. The Second Interim Report on an Investigation of Industrial Fatigue by Physiological Methods. (Cd. 8335.)

2.* HEALTH OF MUNITION WORKERS COMMITTEE. Interim Report, Industrial Efficiency and Fatigue. (Cd. 8511.)

3. Reports of the Industrial Fatigue Research Board. (His Majesty's Stationary Office.)

4.* DR. C. S. MYERS. Mind and Work. (University of London Press, Ltd.)

5. DR. J. DREVER. The Psychology of Industry. (Methuen.)

6. Industrial Administration. A series of lectures, including one by Professor T. H. Pear on "The Applications of Psychology to Industry," one by Dr. Stanley Kent on "Industrial Fatigue," and one by Dr. Leonard Hill on "Atmospheric Conditions and Efficiency." (Manchester University Press.)

7. DR. H. M. VERNON. Industrial Fatigue and Efficiency. (Routledge and Sons.) Based on war-time investigations.

[1] The Report of the Federal Commission on Industrial Relations.

8. B. Muscio, M.A. Lectures on Industrial Psychology.

9.* The Journals I–V of the National Institute of Industrial Psychology. These journals, for the gift of which I am deeply indebted to Dr. Myers, contain valuable articles and reports of investigations, including those by Dr. Myers, Mr. Eric Farmer and Mr. Cyril Burt.

10. McDougall. An Introduction to Social Psychology.

C. ECONOMICS

1.* Sir Wm. Ashley. Scientific Management and the Engineering Situation. Barnett House Papers, No. 7. (Oxford University Press.)

2. J. A. Hobson. Work and Wealth—a Human Valuation. (Macmillan & Co.)

3.* Prof. Sidney Webb. The Works Manager of To-day. (Longmans.)

4. M. and A. D. McKillop. Efficiency Methods. (Routledge.) Chiefly an account of American practice and principles, but with valuable chapters on its effects on Trade Unionism.

5. Dr. Marshall. Industry and Trade, pp. 368–394. (Macmillan & Co.)

Many economists have touched upon this question, as for example, Professor Pigou in his *Economies of Welfare*.

INDEX

The Mayflower Press, Plymouth. William Brendon & Son, Ltd.

A SELECTION FROM

MESSRS. METHUEN'S PUBLICATIONS

This catalogue contains only a selection of the more important books published by Messrs. Methuen. A complete catalogue of their publications may be obtained on application.

Allcroft (A. Hadrian). DOWNLAND PATHWAYS. With Preface by E. V. LUCAS. Illustrated. *Crown* 8vo. 7s. 6d *net.*

Archer (D.). CORSICA: THE SCENTED ISLE. Illustrated. *Demy* 8vo. 10s. 6d. *net.*

Armstrong (W. W.). THE ART OF CRICKET. *Third Edition. Cr.* 8vo. 3s. *net.*

Bain (F. W.)—
A DIGIT OF THE MOON: A Hindoo Love Story. THE DESCENT OF THE SUN: A Cycle of Birth. A HEIFER OF THE DAWN. IN THE GREAT GOD'S HAIR. A DRAUGHT OF THE BLUE. AN ESSENCE OF THE DUSK. AN INCARNATION OF THE SNOW. A MINE OF FAULTS. THE ASHES OF A GOD. BUBBLES OF THE FOAM. A SYRUP OF THE BEES. THE LIVERY OF EVE. THE SUBSTANCE OF A DREAM. *All Fcap.* 8vo. 5s. *net.* AN ECHO OF THE SPHERES. *Wide Demy* 8vo. 10s. 6d. *net.*

Baker (C. H. Collins). CROME. Illustrated. *Quarto.* £5, 5s. *net.*

Balfour (Sir Graham). THE LIFE OF ROBERT LOUIS STEVENSON. *Twentieth Edition. In one Volume. Cr.* 8vo. *Buckram,* 7s. 6d. *net.*

Bell (Aubrey F. G.). A PILGRIM IN SPAIN. Illustrated. *Demy* 8vo. 12s. 6d. *net.*

Belloc (H.)—
PARIS, 8s. 6d. *net.* HILLS AND THE SEA, 6s. *net.* ON NOTHING AND KINDRED SUBJECTS, 6s. *net.* ON EVERYTHING, 6s. *net.* ON SOMETHING, 6s. *net.* FIRST AND LAST, 6s. *net.* THIS AND THAT AND THE OTHER, 6s. *net.* ON, 6s. *net.* ON ANYTHING, 6s. *net.* MARIE ANTOINETTE, 18s. *net.* THE PYRENEES. 8s. 6d. *net.*

Butler (Kathleen T.). A HISTORY OF FRENCH LITERATURE. *Two Vols. Each Cr.* 8vo. 10s. 6d. *net.*

Campbell (Olwen Ward). SHELLEY AND THE UNROMANTICS. Illustrated *Second Edition, Revised. Demy* 8vo. 16s. *net.*

Chandler (Arthur), D.D., late Lord Bishop of Bloemfontein—
ARA CELI: An Essay in Mystical Theology, 3s. 6d. *net.* FAITH AND EXPERIENCE, 5s. *net.* THE CULT OF THE PASSING MOMENT, 6s. *net.* THE ENGLISH CHURCH AND REUNION, 5s. *net.* SCALA MUNDI, 4s. 6d. *net.*

Chesterton (G. K.)—
THE BALLAD OF THE WHITE HORSE. ALL THINGS CONSIDERED. TREMENDOUS TRIFLES. ALARMS AND DISCURSIONS. A MISCELLANY OF MEN. THE USES OF DIVERSITY. FANCIES VERSUS FADS. *All Fcap.* 8vo. 6s. *net.* CHARLES DICKENS. *Fcap.* 8vo. 3s. 6d. *net.* WINE, WATER, AND SONG. *Fcap.* 8vo. 1s. 6d. *net.*

Clutton-Brock (A.)—
WHAT IS THE KINGDOM OF HEAVEN? *Fifth Edition. Fcap.* 8vo. 5s. *net.* ESSAYS ON ART. *Second Edition. Fcap.* 8vo. 5s. *net.* ESSAYS ON BOOKS. *Third Edition. Fcap.* 8vo. 6s. *net.* MORE ESSAYS ON BOOKS. *Fcap.* 8vo. 6s. *net.* SHAKESPEARE'S HAMLET. *Fcap.* 8vo. 3s. *net.* SHELLEY: THE MAN AND THE POET. *Second Edition, Revised. Fcap.* 8vo. 7s. 6d. *net.*

Conrad (Joseph). THE MIRROR OF THE SEA: Memories and Impressions. *Fourth Edition. Fcap.* 8vo. 6s. *net.* Also Uniform Edition, 3s. 6d. *net.*

Dark (Sidney) and Grey (Rowland). W. S. GILBERT: His Life and Letters. Illustrated. *Second Edition. Demy* 8vo. 12s. *net.*

Dolls' House (The Queen's). THE BOOK OF THE QUEEN'S DOLLS' HOUSE. Vol. I. THE QUEEN'S DOLLS' HOUSE. Edited by A. C. BENSON, C.V.O., and SIR LAWRENCE WEAVER, K.B.E. Vol. II. THE QUEEN'S DOLLS' HOUSE LIBRARY. Edited by E. V. LUCAS. Illustrated. A Limited Edition. *Crown* 4to. £6, 6s. *net.*

EVERYBODY'S BOOK OF THE QUEEN'S DOLLS' HOUSE. Illustrated. *Crown* 4to. 5s. *net.*

Drever (James)—
THE PSYCHOLOGY OF EVERYDAY LIFE. (*Fourth Edition*) *Cr.* 8vo. 6s. *net.* THE PSYCHOLOGY OF INDUSTRY. *Cr.* 8vo. 5s. *net.*

Dutt (W. A.). A GUIDE TO THE NORFOLK BROADS. Illustrated. *Demy* 8vo. 6s. *net.*

Edwardes (Tickner). THE LORE OF THE HONEY-BEE. *Tenth Edition. Cr.* 8vo. 7s. 6d. *net.*

Einstein (A.). RELATIVITY: THE SPECIAL AND THE GENERAL THEORY. Translated by ROBERT W. LAWSON. *Eighth Edition. Cr.* 8vo. 5s. *net.*

SIDELIGHTS ON RELATIVITY. Two Lectures by ALBERT EINSTEIN. *Cr.* 8vo. 3s. 6d. *net.*

THE MEANING OF RELATIVITY. *Cr.* 8vo. 5s. *net.*
Other Books on the Einstein Theory.

SPACE—TIME—MATTER. By HERMANN WEYL. *Demy* 8vo. 18s. *net.*

THE PRINCIPLE OF RELATIVITY. By ALBERT EINSTEIN, H. A. LORENTZ, H. MINKOWSKI, and H. WEYL. With notes by A. SOMMERFELD. *Demy* 8vo, 12s. 6d. *net.*

RELATIVITY AND THE UNIVERSE. By HARRY SCHMIDT. *Second Edition. Cr.* 8vo. 5s. *net.*

THE THEORY OF RELATIVITY. By Prof. ERWIN FREUNDLICH. *Cr.* 8vo. 5s. *net.*

RELATIVITY FOR ALL. By HERBERT DINGLE. *Third Edition. Fcap.* 8vo. 2s. *net.*

Evans (Joan). ENGLISH JEWELLERY. *Royal* 4to. £2, 12s. 6d. *net.*

Fitzgerald (Edward). THE RUBA'IYAT OF OMAR KHAYYAM. An edition illustrated by EDMUND J. SULLIVAN. *Wide Cr.* 8vo. 10s. 6d. *net.*

Fyleman (Rose)—
FAIRIES AND CHIMNEYS (*Eighteenth Edition*). THE FAIRY GREEN (*Tenth Edition*). THE FAIRY FLUTE (*Eighth Edition*). THE RAINBOW CAT AND OTHER STORIES (*Second Edition*). FORTY GOOD-NIGHT TALES (*Third Edition*). EIGHT LITTLE PLAYS FOR CHILDREN. *All Fcap.* 8vo, 3s 6d. *net.* A SMALL CRUSE. *Fcap.* 8vo. 4s. 6d. *net.* THE ROSE FYLEMAN FAIRY BOOK. Illustrated. *Crown* 4to. 10s. 6d. *net.*

Geering (Thomas). OUR SUSSEX PARISH. With an Introduction and biographical chapter by ARTHUR BECKETT. Illustrated. *Crown* 8vo. 10s. 6d. *net.*

Gibbins (H. de B.). INDUSTRY IN ENGLAND: HISTORICAL OUTLINES. With Maps and Plans. *Tenth Edition. Demy* 8vo. 12s. 6d. *net.*

THE INDUSTRIAL HISTORY OF ENGLAND. With 5 Maps and a Plan. *Twenty-seventh Edition. Cr.* 8vo. 5s.

Gibbon (Edward). THE DECLINE AND FALL OF THE ROMAN EMPIRE. Edited, with Notes, Appendices, and Maps, by J. B. BURY. *Seven Volumes. Demy* 8vo. Illustrated. *Each* 12s. 6d. *net. Also in Seven Volumes.* Unillustrated. *Cr.* 8vo. *Each* 7s. 6d. *net.*

Glover (T. R.)—
THE CONFLICT OF RELIGIONS IN THE EARLY ROMAN EMPIRE, 10s. 6d. *net.* POETS AND PURITANS, 10s. 6d. *net.* FROM PERICLES TO PHILIP, 10s. 6d. *net.* VIRGIL, 10s. 6d. *net.*

Graham (Harry). THE WORLD WE LAUGH IN: MORE DEPORTMENTAL DITTIES. Illustrated by "FISH." *Second Edition. Fcap.* 8vo. 5s. *net.*

Grahame (Kenneth). THE WIND IN THE WILLOWS. *Fourteenth Edition. Cr.* 8vo. 7s. 6d. *net.*
Also, Illustrated by NANCY BARNHART. *Small* 4to. 10s. 6d. *net.*

Hadfield (J. A.). PSYCHOLOGY AND MORALS: An Analysis of Character. *Fourth Edition. Cr.* 8vo. 6s. *net.*

Hall (H. R.). THE ANCIENT HISTORY OF THE NEAR EAST FROM THE EARLIEST TIMES TO THE BATTLE OF SALAMIS. Illustrated. *Sixth Edition, Revised. Demy* 8vo. 22s. *net.*

Hind (A. M.). A CATALOGUE OF REMBRANDT'S ETCHINGS. *Two vols. Illustrated. Wide Royal* 8vo. £1, 15s. *net.*

Holdsworth (W. S.). A HISTORY OF ENGLISH LAW. *Seven Volumes. Demy* 8vo. *Each* 25s. *net.*

Hoppé (E. O.). IN GIPSY CAMP AND ROYAL PALACE: WANDERINGS IN RUMANIA. With a Preface by the QUEEN OF RUMANIA. Illustrated. *Demy* 8vo. 15s. *net.*

Hudson (W. H.). A SHEPHERD'S LIFE. Illustrated. *Demy.* 8vo. *Sixth Edition.* 10s. 6d. *net. Also Fcap.* 8vo. 3s. 6d. *net.*

Inge (W. R.). CHRISTIAN MYSTICISM (The Bampton Lectures of 1899). *Fifth Edition. Cr.* 8vo. 7s. 6d. *net.*

Jenks (E.). AN OUTLINE OF ENGLISH LOCAL GOVERNMENT. *Fifth Edition. Cr.* 8vo. 5s. *net.*

A SHORT HISTORY OF ENGLISH LAW: FROM THE EARLIEST TIMES TO THE END OF THE YEAR 1919. *Third Edition, Revised. Demy* 8vo. 12s. 6d. *net.*

Jones (M. E. Monckton). ANCIENT EGYPT FROM THE RECORDS. Illustrated. *Crown* 8vo. 7s. 6d. *net.*

Julian (Lady) of Norwich. REVELATIONS OF DIVINE LOVE. Edited by GRACE WARRACK. *Eighth Edition. Cr.* 8vo. 5s. *net.*

Keats (John). POEMS. Edited, with Introduction and Notes, by E. DE SELINCOURT. With a Frontispiece in Photogravure. *Fourth Edition. Demy* 8vo 12s. 6d. *net.*

Kidd (Benjamin)—
THE SCIENCE OF POWER (*Ninth Edition*) *Cr.* 8vo. 7s. 6d. *net.* SOCIAL EVOLUTION *Demy* 8vo. 8s. 6d. *net.*

Kipling (Rudyard). BARRACK-ROOM BALLADS. 233*rd Thousand. Cr.* 8vo *Buckram,* 7s. 6d. *net. Also Fcap.* 8vo *Cloth,* 6s. *net; leather,* 7s. 6d. *net.*
Also a Service Edition. *Two Volumes Square Fcap.* 8vo. *Each* 3s. *net.*
THE SEVEN SEAS. 172*nd Thousand Cr.* 8vo. *Buckram,* 7s. 6d. *net. Als Fcap.* 8vo. *Cloth,* 6s. *net; leather,* 7s. 6d. *ne*
Also a Service Edition. *Two Volume Square Fcap.* 8vo. *Each* 3s. *net.*
THE FIVE NATIONS. 138*th Thousan Cr.* 8vo. *Buckram,* 7s. 6d. *net. Al Fcap.* 8vo. *Cloth,* 6s. *net; leather,* 7s. 6d. *ne*
Also a Service Edition. *Two Volume Square Fcap.* 8vo. *Each* 3s. *net.*
DEPARTMENTAL DITTIES. 111*Thousand. Cr.* 8vo. *Buckram,* 7s. 6 *net. Also Fcap.* 8vo. *Cloth,* 6s. *ne leather,* 7s. 6d. *net.*
Also a Service Edition. *Two Volume Square Fcap.* 8vo. *Each* 3s. *net.*
THE YEARS BETWEEN. 95*th Thousan Cr.* 8vo. *Buckram,* 7s. 6d. *net. Fca* 8vo. *Cloth,* 6s. *net; leather,* 7s. 6d. *n*
Also a Service Edition. *Two Volum Square Fcap.* 8vo. *Each* 3s. *net.*
A KIPLING ANTHOLOGY—VERS *Third Edition. Fcap.* 8vo. *Cloth,* 6s. *n Leather,* 7s. 6d. *net.*
TWENTY POEMS FROM RUDYAR KIPLING. 397*th Thousand. Fcap.* 8 1s. *net.*

Lamb (Charles and Mary). THE COMPLETE WORKS. Edited by E. V. LUCAS. *A New and Revised Edition in Six Volumes. With Frontispieces. Fcap. 8vo. Each 6s. net.*

The volumes are:—

I. MISCELLANEOUS PROSE. II. ELIA AND THE LAST ESSAYS OF ELIA. III. BOOKS FOR CHILDREN. IV. PLAYS AND POEMS. V. and VI. LETTERS.

Lankester (Sir Ray).—

SCIENCE FROM AN EASY CHAIR (*Fifteenth Edition*). SCIENCE FROM AN EASY CHAIR: *Second Series* (*Third Edition*). DIVERSIONS OF A NATURALIST (*Third Edition*) GREAT AND SMALL THINGS. All Illustrated. *Crown 8vo. 7s. 6d. net.* SECRETS OF EARTH AND SEA (*Second Edition*). Illustrated. *Crown 8vo. 8s. 6d. net.*

Lodge (Sir Oliver). MAN AND THE UNIVERSE. *Ninth Edition. Cr. 8vo. 7s. 6d. net.*

THE SURVIVAL OF MAN: A STUDY IN UNRECOGNIZED HUMAN FACULTY. *Seventh Edition. Cr. 8vo. 7s. 6d. net.*

RAYMOND REVISED. *Cr. 8vo. 6s. net.*

Lorimer (Norma). BY THE WATERS OF EGYPT. Illustrated. *Fourth Edition. Cr. 8vo. 7s. 6d. net.*

Loring (F. H.). ATOMIC THEORIES. *Second Edition. Demy 8vo. 12s. 6d. net.*

THE CHEMICAL ELEMENTS. *Demy 8vo. 8s. 6d. net.*

Lucas (E. V.)—

THE LIFE OF CHARLES LAMB, *2 vols., 25s. net.* EDWIN AUSTIN ABBEY, R.A. *2 vols. £6, 6s. net.* VERMEER OF DELFT, 10s. 6d. *net.* A WANDERER IN HOLLAND, 10s 6d. *net.* A WANDERER IN LONDON, 10s. 6d. *net.* LONDON REVISITED, 10s. 6d. *net.* A WANDERER IN PARIS, 10s. 6d. *net.* A WANDERER IN FLORENCE, 10s. 6d. *net.* A WANDERER IN VENICE, 10s. 6d. *net.* A WANDERER AMONG PICTURES. 8s. 6d. *net.* THE OPEN ROAD: A Little Book for Wayfarers, 6s. *net.* Also an edition illustrated by Claude A. Shepperson, 10s. 6d. *net.* Also an edition on India paper, leather, 7s. 6d. *net.* THE FRIENDLY TOWN: A Little Book for the Urbane, 6s. *net.* FIRESIDE AND SUNSHINE, 6s. *net.* CHARACTER AND COMEDY, 6s. *net.* THE GENTLEST ART: A Choice of Letters by Entertaining Hands, 6s. 6d. *net.* THE SECOND POST, 6s. *net.* HER INFINITE VARIETY: A Feminine Portrait Gallery, 6s. *net.* GOOD COMPANY: A Rally of Men, 6s. *net.* ONE DAY AND ANOTHER, 6s. *net.* OLD LAMPS FOR NEW, 6s. *net.* LOITERER'S HARVEST, 6s. *net.* CLOUD AND SILVER, 6s. *net.* A BOSWELL OF BAGHDAD, AND OTHER ESSAYS, 6s. *net.* TWIXT EAGLE AND DOVE, 6s. *net.* THE PHANTOM JOURNAL, AND OTHER ESSAYS AND DIVERSIONS, 6s. *net.* GIVING AND RECEIVING, 6s. *net.* LUCK OF THE YEAR, 6s. *net.* ENCOUNTERS AND DIVERSIONS, 6s. *net.* SPECIALLY SELECTED: A Choice of Essays, 7s. 6d. *net.* URBANITIES. Illustrated by G. L. STAMPA, 7s. 6d. *net.* YOU KNOW WHAT PEOPLE ARE. 5s. *net* THE SAME STAR: A Comedy in Three Acts. 3s. 6d. *net.* THE BRITISH SCHOOL: An Anecdotal Guide to the British Painters and Paintings in the National Gallery, 6s. *net.* LITTLE BOOKS ON THE GREAT MASTERS, 5s. *net each.* ROVING EAST AND ROVING WEST: 5s. *net.* See also **Dolls' House (The Queen's).**

Lynd (Robert). THE BLUE LION and Other Essays. *Fcap. 8vo. 6s. net.*

THE PEAL OF BELLS. *Fcap 8vo 6s. net.*

Masefield (John). ON THE SPANISH MAIN. *Third Edition. Cr. 8vo. 8s. 6d. net.*

A SAILOR'S GARLAND. *Third Edition. Fcap. 8vo. 6s. net.*

SEA LIFE IN NELSON'S TIME. Illustrated. *Second Edition. Cr. 8vo. 5s. net.*

Meldrum (D. S.). REMBRANDT'S PAINTINGS. *Wide Royal 8vo. £3, 3s. net.*

Methuen (A.). AN ANTHOLOGY OF MODERN VERSE. With Introduction by ROBERT LYND. *Seventeenth Edition. Fcap. 8vo. 6s. net. Thin paper, leather, 7s. 6d. net.*

SHAKESPEARE TO HARDY: AN ANTHOLOGY OF ENGLISH LYRICS. With an Introduction by ROBERT LYND. *Third Edition. Fcap. 8vo, 6s. net. Leather, 7s. 6d. net.*

McDougall (William). AN INTRODUCTION TO SOCIAL PSYCHOLOGY. *Nineteenth Edition. Cr. 8vo. 8s. 6d. net.*

NATIONAL WELFARE AND NATIONAL DECAY. *Cr. 8vo. 6s. net.*

AN OUTLINE OF PSYCHOLOGY. *Demy 8vo. 12s. net.*

BODY AND MIND: A HISTORY AND A DEFENCE OF ANIMISM. *Fifth Edition. Demy 8vo. 12s. 6d. net.*

ETHICS AND SOME MODERN WORLD PROBLEMS. *Crown 8vo. 7s. 6d. net.*

Maeterlinck (Maurice)—

THE BLUE BIRD: A Fairy Play in Six Acts. 6s. *net.* Also an edition illustrated by F. Cayley Robinson, 10s. 6d. *net.* MARY MAGDALENE: A Play in Three Acts, 5s. *net.* DEATH, 3s. 6d. *net.* OUR ETERNITY, 6s. *net.* THE UNKNOWN GUEST, 6s. *net.* POEMS, 5s. *net.* THE WRACK OF THE STORM, 6s. *net.* THE MIRACLE OF ST. ANTHONY: A Play in One Act, 3s. 6d. *net.* THE BURGOMASTER OF STILEMONDE: A Play in Three Acts, 5s. *net.* THE BETROTHAL; or, The Blue Bird Chooses, 6s. *net.* MOUNTAIN PATHS, 6s. *net.* THE STORY OF TYLTYL, 21s. *net.* THE GREAT SECRET. 7s. 6d. *net.* THE CLOUD THAT LIFTED, and THE POWER OF THE DEAD. 7s. 6d. *net.*

Milne (A. A.)—

NOT THAT IT MATTERS. IF I MAY. *Each Fcap. 8vo. 6s. net.* Also Uniform Edition. *Fcap. 8vo. 3s. 6d. net each.* WHEN WE WERE VERY YOUNG. Illustrated by E. H. Shepard. *Crown 8vo. 7s. 6d. net.*

Newman (Tom). HOW TO PLAY BILLIARDS. Illustrated. *Cr. 8vo, 8s. 6d. net.*

BILLIARD DO'S AND DONT'S. *Fcap. 8vo. 2s. 6d. net.*

Oman (Sir Charles). A HISTORY OF THE ART OF WAR IN THE MIDDLE AGES. A.D. 378–1485. *Second Edition, Revised and enlarged. In two Volumes.* Illustrated. *Demy* 8vo. 36s. *net.*

Oxenham (John)—
BEES IN AMBER; A Little Book of Thoughtful Verse. *Small Pott* 8vo. *Stiff Boards.* 2s. *net.* ALL'S WELL; A Collection of War Poems. THE KING'S HIGH WAY. THE VISION SPLENDID. THE FIERY CROSS. HIGH ALTARS: The Record of a Visit to the Battlefields of France and Flanders. HEARTS COURAGEOUS. ALL CLEAR! *All Small Pott* 8vo. *Paper,* 1s. 3d. *net; cloth boards,* 2s. *net.* WINDS OF THE DAWN. 2s. *net.*

Perry (W. J.)—
THE ORIGIN OF MAGIC AND RELIGION. THE GROWTH OF CIVILIZATION. With Maps. *Each Crown* 8vo., 6s. *net.* THE CHILDREN OF THE SUN: A STUDY IN THE EARLY HISTORY OF CIVILIZATION. With Maps. *Demy* 8vo. 18s. *net.*

Petrie (Sir Flinders). A HISTORY OF EGYPT. Illustrated. *Six Volumes. Cr.* 8vo. *Each* 9s. *net.*
VOL. I. FROM THE IST TO THE XVITH DYNASTY. *Eleventh Edition, Revised.* (12s. *net.*)
VOL. II. THE XVIITH AND XVIIITH DYNASTIES. *Seventh Edition, Revised.*
VOL. III. XIXTH TO XXXTH DYNASTIES. *Second Edition.*
VOL. IV. EGYPT UNDER THE PTOLEMAIC DYNASTY. J. P. MAHAFFY. *Second Edition.*
VOL. V. EGYPT UNDER ROMAN RULE. J. G. MILNE. *Third Edition, Revised.*
VOL. VI. EGYPT IN THE MIDDLE AGES. STANLEY LANE POOLE. *Third Edition.* (10s. *net.*)

SYRIA AND EGYPT, FROM THE TELL EL AMARNA LETTERS. *Cr.* 8vo. 5s. *net.*

EGYPTIAN TALES. Translated from the Papyri. First Series, IVth to XIIth Dynasty. Illustrated. *Third Edition. Cr.* 8vo. 5s. *net.*

EGYPTIAN TALES. Translated from the Papyri. Second Series, XVIIIth to XIXth Dynasty. Illustrated. *Third Edition. Cr.* 8vo. 5s. *net.*

Pollitt (Arthur W.). THE ENJOYMENT OF MUSIC. *Second Edition. Cr.* 8vo. 5s. *net.*

Ponsonby (Arthur). ENGLISH DIARIES. *Second Edition. Demy* 8vo. 21s. *net.*

Power (Eileen). MEDIEVAL PEOPLE. Illustrated. *Crown* 8vo. 6s. *net.*

Price (L. L.). A SHORT HISTORY OF POLITICAL ECONOMY IN ENGLAND FROM ADAM SMITH TO ARNOLD TOYNBEE. *Twelfth Edition. Cr.* 8vo. 5s. *net.*

Selous (Edmund)—
TOMMY SMITH'S ANIMALS. TOMMY SMITH'S OTHER ANIMALS. TOMMY SMITH AT THE ZOO. TOMMY SMITH AGAIN AT THE ZOO. *Each* 2s. 9d. TOMMY SMITH'S BIRDS, 2s. 6d. JACK'S INSECTS, 3s. 6d. JACK'S OTHER INSECTS, 3s. 6d. All Illustrated.

Smith (Adam). THE WEALTH OF NATIONS. Edited by EDWIN CANNAN. *Two Volumes. Third Edition. Demy* 8vo. £1, 5s. *net.*

Smith (C. Fox).
SAILOR TOWN DAYS. SEA SONGS AND BALLADS. A BOOK OF FAMOUS SHIPS. SHIP ALLEY: MORE SAILOR TOWN DAYS. All Illustrated. *Cr.* 8vo. 6s. *net. each.* THE RETURN OF "THE CUTTY SARK." Illustrated *Crown* 8vo. 2s 6d. *net.*

Sommerfeld (Arnold). ATOMIC STRUCTURE AND SPECTRAL LINES. *Demy* 8vo. 32s. *net.*

Stevenson (R. L.). THE LETTERS OF ROBERT LOUIS STEVENSON. Edited by SIR SIDNEY COLVIN. *A New Re-arranged Edition in four volumes. Fourth Edition. Fcap.* 8vo. *Each* 6s. *net.*

Surtees (R. S.)—
HANDLEY CROSS, 7s. 6d. *net.* MR. SPONGE'S SPORTING TOUR, 7s. 6d. *net.* ASK MAMMA: OR, The Richest Commoner in England, 7s. 6d. *net.* JORROCKS'S JAUNTS AND JOLLITIES, 6s. *net.* MR. FACEY ROMFORD'S HOUNDS, 7s. 6d. *net.* HAWBUCK GRANGE; OR, The Sporting Adventures of Thomas Scott, Esq., 6s. *net.* PLAIN OR RINGLETS? 7s. 6d. *net.* HILLINGDON HALL, 7s. 6d. *net.*

Tatchell (Frank). THE HAPPY TRAVELLER: A BOOK FOR POOR MEN. *Fourth Edition. Cr.* 8vo. 7s. 6d. *net.*

Thomson (J. Arthur). WHAT IS MAN? *Second Edition. Cr* 8vo. 6s. 6d. *net.*
SCIENCE AND RELIGION. *Crown* 8vo. 7s. 6d *net.*

Tilden (W. T.)—
THE ART OF LAWN TENNIS (*Sixth Edition*) SINGLES AND DOUBLES (*Second Edition*). *Each. Illustrated. Crown* 8vo. 6s. *net.* THE COMMON SENSE OF LAWN TENNIS. Illustrated. *Crown* 8vo. 5s. *net.*

Tileston (Mary W.). DAILY STRENGTH FOR DAILY NEEDS. *Twenty-ninth Edition. Medium* 16mo. 3s. 6d. *net.*

Underhill (Evelyn). MYSTICISM. A Study in the Nature and Development of Man's Spiritual Consciousness. *Tenth Edition. Demy* 8vo. 15s. *net.*

THE LIFE OF THE SPIRIT AND THE LIFE OF TO-DAY. *Fifth Edition. Cr.* 8vo. 7s. 6d. *net.*

Vardon (Harry). HOW TO PLAY GOLF. Illustrated. *Eighteenth Edition. Cr.* 8vo. 5s. *net.*

Waterhouse (Elizabeth). A LITTLE BOOK OF LIFE AND DEATH. *Twenty-second Edition. Small Pott* 8vo. 2s. 6d. *net.*

Wegener (A.). THE ORIGIN OF CONTINENTS AND OCEANS. *Demy* 8vo. 10s. 6d. *net.*

Wells (J.). A SHORT HISTORY OF ROME. *Nineteenth Edition.* With 3 Maps. *Cr.* 8vo. 5s.

Wilde (Oscar). THE WORKS OF OSCAR WILDE. *Fcap.* 8vo. *Each* 6s. 6d. *net.*

I. LORD ARTHUR SAVILE'S CRIME AND THE PORTRAIT OF MR. W. H. II. THE DUCHESS OF PADUA. III. POEMS. IV. LADY WINDERMERE'S FAN. V. A WOMAN OF NO IMPORTANCE. VI. AN IDEAL HUSBAND. VII. THE IMPORTANCE OF BEING EARNEST. VIII. A HOUSE OF POMEGRANATES. IX. INTENTIONS. X. DE PROFUNDIS AND PRISON LETTERS. XI. ESSAYS. XII. SALOMÉ, A FLORENTINE TRAGEDY, and LA SAINTE COURTISANE. XIII. A CRITIC IN PALL MALL. XIV. SELECTED PROSE OF OSCAR WILDE. XV. ART AND DECORATION. XVI. FOR LOVE OF THE KING: A Burmese Masque (5s. *net*.).

Yeats (W. B.). A BOOK OF IRISH VERSE. *Fourth Edition. Cr.* 8vo. 7s. *net.*

PART II.—A SELECTION OF SERIES

The Antiquary's Books

Demy 8vo. 10s. 6d. *net each volume. With Numerous Illustrations*

ANCIENT PAINTED GLASS IN ENGLAND. ARCHÆOLOGY AND FALSE ANTIQUITIES. THE BELLS OF ENGLAND. THE BRASSES OF ENGLAND. THE CASTLES AND WALLED TOWNS OF ENGLAND. CHURCHWARDENS' ACCOUNTS. THE DOMESDAY INQUEST. ENGLISH CHURCH FURNITURE. ENGLISH MONASTIC LIFE. ENGLISH SEALS. FOLK-LORE AS AN HISTORICAL SCIENCE. THE GUILDS AND COMPANIES OF LONDON. THE HERMITS AND ANCHORITES OF ENGLAND. THE MANOR AND MANORIAL RECORDS. THE MEDIÆVAL HOSPITALS OF ENGLAND. OLD ENGLISH INSTRUMENTS OF MUSIC. OLD ENGLISH LIBRARIES. OLD SERVICE BOOKS OF THE ENGLISH CHURCH. PARISH LIFE IN MEDIÆVAL ENGLAND. THE PARISH REGISTERS OF ENGLAND. REMAINS OF THE PREHISTORIC AGE IN ENGLAND. THE ROMAN ERA IN BRITAIN. ROMANO-BRITISH BUILDINGS AND EARTHWORKS. THE ROYAL FORESTS OF ENGLAND. THE SCHOOLS OF MEDIÆVAL ENGLAND. SHRINES OF BRITISH SAINTS.

The Arden Shakespeare

General Editor, R. H. CASE

Wide Demy 8vo. 6s. *net each volume*

An edition of Shakespeare in Single Plays; each edited with a full Introduction, Textual Notes, and a Commentary at the foot of the page.

The Arden Shakespeare has now been completed by the publication of MUCH ADO ABOUT NOTHING. Edited by GRACE R. TRENERY.

Classics of Art

Edited by DR. J. H. W. LAING

With numerous Illustrations. Wide Royal 8vo.

THE ART OF THE GREEKS, 21s. *net*. THE ART OF THE ROMANS, 16s. *net*. CHARDIN, 15s. *net*. DONATELLO, 16s. *net*. FLORENTINE SCULPTORS OF THE RENAISSANCE, 21s. *net*. GEORGE ROMNEY, 15s. *net*. GHIRLANDAIO, 15s. *net*. LAWRENCE, 25s. *net*. MICHELANGELO, 21s. *net*. RAPHAEL, 15s. *net*. REMBRANDT'S PAINTINGS, 63s. *net*. RUBENS, 30s. *net*. TINTORETTO, 16s. *net*. TITIAN, 16s. *net*. TURNER'S SKETCHES AND DRAWINGS, 15s. *net*. VELASQUEZ, 15s. *net*.

The "Complete" Series

Fully Illustrated. Demy 8vo

THE COMPLETE AIRMAN, 16s. *net*. THE COMPLETE AMATEUR BOXER, 10s. 6d. *net*. THE COMPLETE ATHLETIC TRAINER, 10s. 6d. *net*. THE COMPLETE BILLIARD PLAYER, 10s. 6d. *net*. THE COMPLETE COOK, 10s. 6d. *net*. THE COMPLETE FOXHUNTER, 16s. *net*. THE COMPLETE GOLFER, 12s. 6d. *net*. THE COMPLETE HOCKEY PLAYER, 10s. 6d. *net*. THE COMPLETE HORSEMAN, 15s. *net*. THE COMPLETE JUJITSUAN. (*Cr.* 8vo.) 5s. *net*. THE COMPLETE LAWN TENNIS PLAYER, 12s. 6d. *net*. THE COMPLETE MOTORIST, 10s. 6d. *net*. THE COMPLETE MOUNTAINEER, 18s. *net*. THE COMPLETE OARSMAN, 12s. 6d. *net*. THE COMPLETE PHOTOGRAPHER, 12s. 6d. *net*. THE COMPLETE RUGBY FOOTBALLER, ON THE NEW ZEALAND SYSTEM, 12s. 6d. *net*. THE COMPLETE SHOT, 16s. *net*. THE COMPLETE SWIMMER, 10s. 6d. *net*. THE COMPLETE YACHTSMAN, 15s. *net*.

The Connoisseur's Library

With numerous Illustrations. Wide Royal 8vo. £1, 11s. 6d. net each volume

ENGLISH COLOURED BOOKS. ETCHINGS. EUROPEAN ENAMELS. FINE BOOKS. GLASS. GOLDSMITHS' AND SILVERSMITHS' WORK. ILLUMINATED MANUSCRIPTS. IVORIES. JEWELLERY. MEZZOTINTS. MINIATURES. PORCELAIN. SEALS. WOOD SCULPTURE.

Health Series

Fcap. 8vo. 2s. 6d. net each volume

THE BABY. THE CARE OF THE BODY. THE CARE OF THE TEETH. THE EYES OF OUR CHILDREN. HEALTH FOR THE MIDDLE-AGED. THE HEALTH OF A WOMAN. THE HEALTH OF THE SKIN. HOW TO LIVE LONG. THE PREVENTION OF THE COMMON COLD. STAYING THE PLAGUE. THROAT AND EAR TROUBLES. TUBERCULOSIS. THE HEALTH OF THE CHILD, *2s. net.*

The Library of Devotion

Handy Editions of the great Devotional Books, well edited
With Introductions and (where necessary) Notes

Small Pott 8vo, cloth, 3s. net and 3s. 6d. net

Little Books on Art

With many Illustrations. Demy 16mo. 5s. net each volume

Each volume consists of about 200 pages, and contains from 30 to 40 Illustrations, including a Frontispiece in Photogravure

ALBRECHT DÜRER. THE ARTS OF JAPAN. BOOKPLATES. BOTTICELLI. BURNE-JONES. CELLINI. CHRIST IN ART. CLAUDE. CONSTABLE. COROT. EARLY ENGLISH WATER-COLOUR. ENAMELS. FREDERIC LEIGHTON. GEORGE ROMNEY. GREEK ART. GREUZE AND BOUCHER. HOLBEIN. ILLUMINATED MANUSCRIPTS. JEWELLERY. JOHN HOPPNER. Sir JOSHUA REYNOLDS. MILLET. MINIATURES. OUR LADY IN ART. RAPHAEL. RODIN. TURNER. VANDYCK. WATTS.

The Little Guides

With many Illustrations by E. H. NEW and other artists, and from photographs, Maps and Plans

Small Pott 8vo. 4s. net to 7s. 6d. net each

Guides to the English and Welsh Counties, and some well-known districts.

The main features of these Guides are (1) a handy and charming form; (2) illustrations from photographs and by well-known artists; (3) good plans and maps; (4) an adequate but compact presentation of everything that is interesting in the natural features, history, archæology, and architecture of the town or district treated.

Plays

Fcap. 8vo. 3s. 6d. net each

MILESTONES. Arnold Bennett and Edward Knoblock. *Eleventh Edition.*
IDEAL HUSBAND, AN. Oscar Wilde. *Acting Edition.*
KISMET. Edward Knoblock. *Fourth Edition.*
WARE CASE, THE. George Pleydell.
THE SAME STAR. E. V. Lucas.
THE GREAT ADVENTURE. Arnold Bennett. *Fifth Edition.*
GENERAL POST. J. E. Harold Terry. *Second Edition.*
THE HONEYMOON. Arnold Bennett. *Third Edition.*

Sport Series

Mostly illustrated. Fcap. 8vo

ALL ABOUT FLYING, 3s. *net*. ALPINE SKIING AT ALL HEIGHTS AND SEASONS, 5s. *net*. SKI-ING FOR BEGINNERS, 5s. *net*. GOLF DO'S AND DONT'S, 2s. *net*. QUICK CUTS TO GOOD GOLF, 2s. *net*. INSPIRED GOLF, 2s. 6d. *net*. DRIVING, APPROACHING, PUTTING, 2s. *net*. GOLF CLUBS AND HOW TO USE THEM, 2s. *net*. THE SECRET OF GOLF FOR OCCASIONAL PLAYERS, 2s. *net*. THE GOLFING SWING, 2s. 6d. *net*. GOLF RULES AND DECISIONS. 3s. 6d. *net*. THE AUTOBIOGRAPHY OF A CADDY-BAG, 2s. 6d. *net*. LAWN TENNIS, 2s. 6d. *net*. LAWN TENNIS DO'S AND DONT'S, 2s. 6d. *net*. LAWN TENNIS FOR YOUNG PLAYERS, 2s. 6d. *net*. LAWN TENNIS FOR CLUB PLAYERS, 2s. 6d. *net*. LAWN TENNIS FOR MATCH PLAYERS, 2s. 6d. *net*. LAWN TENNIS FOR PUBLIC COURTS PLAYERS, 2s. 6d. *net*. THE TECHNIQUE OF LAWN TENNIS, 2s. 6d. *net*. THE LAWN TENNIS UMPIRE AND REFEREE, 2s. 6d. *net*. HOCKEY, 4s. *net*. HOW TO SWIM, 2s. *net*. PUNTING, 3s. 6d. *net*. SKATING, 3s. *net*. WRESTLING, 2s. *net*. MOTOR DO'S AND DONT'S, 2s. 6d. *net*. MAH JONG DO'S AND DONT'S, 2s. *net*. AUCTION BRIDGE DO'S AND DONT'S. 3s. *net*. BILLIARD DO'S AND DONT'S. 2s. 6d. *net*.

Methuen's Half-Crown Library

Crown 8vo.

Cheap Editions of Popular Books

Methuen's Two-Shilling Library

Fcap. 8vo.

Write for Complete Lists

PART III.—A SELECTION OF WORKS OF FICTION

Bennett (Arnold)—
CLAYHANGER, 8s. *net*. HILDA LESSWAYS. 8s. 6d. *net*. THESE TWAIN. THE CARD. THE REGENT: A Five Towns Story of Adventure in London. THE PRICE OF LOVE. BURIED ALIVE. A MAN FROM THE NORTH. WHOM GOD HATH JOINED. A GREAT MAN: A Frolic. MR. PROHACK. *All* 7s. 6d. *net*. THE MATADOR OF THE FIVE TOWNS, 6s. *net*.

Birmingham (George A.)—
SPANISH GOLD. THE SEARCH PARTY. THE BAD TIMES. UP, THE REBELS. THE LOST LAWYER. THE GREAT-GRANDMOTHER. FOUND MONEY. *All* 7s. 6d. *net*. INISHKENY, 8s. 6d. *net*.

Brandon (John G.)—THE BIG HEART. *Third Edition. Cr. 8vo.* 3s. 6d. *net*.

Burroughs (Edgar Rice)—
THE RETURN OF TARZAN, 6s. *net*. THE BEASTS OF TARZAN, 6s. *net*. THE SON OF TARZAN, 6s. *net*. JUNGLE TALES OF TARZAN, 6s. *net*. TARZAN AND THE JEWELS OF OPAR, 6s. *net*. TARZAN THE UNTAMED, 7s. 6d. *net*. TARZAN AND THE GOLDEN LION, 3s. 6d. *net*. A PRINCESS OF MARS, 6s. *net*. THE GODS OF MARS, 6s. *net*. THE WARLORD OF MARS, 6s. *net*. THUVIA, MAID OF MARS, 6s. *net*. TARZAN THE TERRIBLE, 2s. 6d. *net*. THE MUCKER, 6s. *net*. THE MAN WITHOUT A SOUL, 6s. *net*. THE CHESSMEN OF MARS, 7s. 6d. *net*. AT THE EARTH'S CORE, 7s. 6d. *net*. PELLUCIDAR, 7s. 6d. *net*. THE GIRL FROM HOLLYWOOD, 7s. 6d. *net*.

Conrad (Joseph)—
A SET OF SIX, 7s. 6d. *net*. VICTORY: An Island Tale. THE SECRET AGENT: A Simple Tale. UNDER WESTERN EYES. CHANCE. *All* 9s. *net*. Also Uniform Edition. *Fcap. 8vo.* 3s. 6d. *net each*.

Corelli (Marie)—
A ROMANCE OF TWO WORLDS, 7s. 6d. *net*. VENDETTA: or, The Story of One Forgotten, 7s. 6d. *net*. THELMA: A Norwegian Princess, 7s. 6d. *net*. ARDATH: The Story of a Dead Self, 7s. 6d. *net*. THE SOUL OF LILITH, 7s. 6d. *net*. WORMWOOD: A Drama of Paris, 7s. 6d. *net*. BARABBAS: A Dream of the World's Tragedy, 7s. 6d. *net*. THE SORROWS OF SATAN, 7s. 6d. *net*. THE MASTER-CHRISTIAN, 7s. 6d. *net*. TEMPORAL POWER: A Study in Supremacy, 6s. *net*. GOD'S GOOD MAN: A Simple Love Story, 7s. 6d. *net*. HOLY ORDERS: The Tragedy of a Quiet Life, 8s. 6d. *net*. THE MIGHTY ATOM, 7s. 6d. *net*. BOY: A Sketch, 7s. 6d. *net*. CAMEOS, 6s. *net*. THE LIFE EVERLASTING. 8s. 6d. *net*. THE LOVE OF LONG AGO, AND OTHER STORIES, 7s. 6d. *net*. INNOCENT, 7s. 6d. *net*. THE SECRET POWER: A Romance of the Time, 6s. *net*. LOVE—AND THE PHILOSOPHER: A Study in Sentiment, 6s. *net*. Also Uniform Edition. *Crown 8vo.* 3s. 6d. *net each*.

Hichens (Robert)—
FELIX: Three Years in a Life, *7s. 6d. net.* THE WOMAN WITH THE FAN, *7s. 6d. net.* THE GARDEN OF ALLAH, *8s. 6d. net.* THE CALL OF THE BLOOD, *8s. 6d. net.* THE DWELLER ON THE THRESHOLD, *7s. 6d. net.* THE WAY OF AMBITION, *7s. 6d. net.* IN THE WILDERNESS, *7s. 6d. net.* AFTER THE VERDICT, *7s. 6d. net.*

Hope (Anthony)—
A CHANGE OF AIR. A MAN OF MARK. SIMON DALE. THE KING'S MIRROR. THE DOLLY DIALOGUES. MRS. MAXON PROTESTS. A YOUNG MAN'S YEAR. BEAUMAROY HOME FROM THE WARS. *All 7s. 6d. net.*

Jacobs (W. W.)—
MANY CARGOES, *5s. net.* SEA URCHINS, *5s. net* and *3s. 6d. net.* A MASTER OF CRAFT, *6s. net.* LIGHT FREIGHTS, *6s. net.* THE SKIPPER'S WOOING, *5s. net.* AT SUNWICH PORT, *5s. net.* DIALSTONE LANE, *5s. net.* ODD CRAFT, *5s. net.* THE LADY OF THE BARGE, *5s. net.* SALTHAVEN, *6s. net.* SAILORS' KNOTS, *5s. net.* SHORT CRUISES, *6s. net.*

Knox (R. A.)—
MEMORIES OF THE FUTURE. *7s. 6d. net.* SANCTIONS: A FRIVOLITY. *7s. 6d. net.*

London (Jack)—WHITE FANG. *Nineteenth Edition. Cr. 8vo. 7s. 6d. net.*

Lucas (E. V.)—
LISTENER'S LURE: An Oblique Narration, *6s. net.* OVER BEMERTON'S: An Easy-going Chronicle, *6s. net.* MR. INGLESIDE, *6s. net.* LONDON LAVENDER, *6s. net.* LANDMARKS, *6s. net.* THE VERMILION BOX, *6s. net.* VERENA IN THE MIDST, *8s. 6d. net.* ROSE AND ROSE, *6s. net.* GENEVRA'S MONEY, *7s. 6d. net.* ADVISORY BEN, *7s. 6d. net.*

McKenna (Stephen)—
SONIA: Between Two Worlds, *8s. net.* NINETY-SIX HOURS' LEAVE, *7s. 6d. net.* THE SIXTH SENSE, *6s. net.* MIDAS & SON, *8s. net.*

Malet (Lucas)—
THE HISTORY OF SIR RICHARD CALMADY: A Romance. *10s. net.* THE CARISSIMA. THE GATELESS BARRIER. DEADHAM HARD. COLONEL ENDERBY'S WIFE, *All 7s. 6d. net.* THE WAGES OF SIN. *8s. net.*

Mason (A. E. W.). CLEMENTINA. Illustrated. *Ninth Edition. 7s. 6d. net.*

Milne (A. A.)—
THE DAY'S PLAY. THE HOLIDAY ROUND. ONCE A WEEK. *All 7s. 6d. net.* THE SUNNY SIDE. *6s. net.* Also Uniform Edition. *Fcap. 8vo. 3s. 6d. net each.* THE RED HOUSE MYSTERY. *6s. net.*

Oxenham (John)—
THE QUEST OF THE GOLDEN ROSE. MARY ALL-ALONE. *7s. 6d. net.*

Parker (Gilbert)—
The TRANSLATION OF A SAVAGE. WHEN VALMOND CAME TO PONTIAC: The Story of a Lost Napoleon. AN ADVENTURER OF THE NORTH: The Last Adventures of "Pretty Pierre." THE SEATS OF THE MIGHTY. THE BATTLE OF THE STRONG: A Romance of Two Kingdoms. THE TRAIL OF THE SWORD. NORTHERN LIGHTS. *All 7s. 6d. net.* THE JUDGMENT HOUSE. *3s. 6d. net.*

Phillpotts (Eden)—
CHILDREN OF THE MIST. THE RIVER. THE HUMAN BOY AND THE WAR. *All 7s. 6d. net.*

Richmond (Grace S.)—
FOURSQUARE. A COURT OF INQUIRY. RUFUS. *All 7s. 6d. net.*

Rohmer (Sax)—
THE GOLDEN SCORPION. *7s. 6d. net.* THE DEVIL DOCTOR. THE MYSTERY OF DR. FU-MANCHU. THE YELLOW CLAW. *All 3s. 6d. net.*

Swinnerton (F.). SHOPS AND HOUSES. SEPTEMBER. THE HAPPY FAMILY. ON THE STAIRCASE. COQUETTE. THE CHASTE WIFE. THE THREE LOVERS. *All 7s. 6d. net.* THE MERRY HEART. THE CASEMENT. THE YOUNG IDEA. *All 6s. net.*

Wells (H. G.). BEALBY. *Fourth Edition. Cr. 8vo. 7s. 6d. net.*

Williamson (Mrs. C. N.). NAME THE WOMAN. *Crown 8vo. 7s. 6d. net.*

Williamson (C. N. and A. M.)—
THE LIGHTNING CONDUCTOR: The Strange Adventures of a Motor-Car. LADY BETTY ACROSS THE WATER. IT HAPPENED IN EGYPT. THE SHOP GIRL. MY FRIEND THE CHAUFFEUR. SET IN SILVER. THE GREAT PEARL SECRET. *All 7s. 6d. net.* CRUCIFIX CORNER. *6s. net.*

Wodehouse (P. G.). CBILL THE CONQUEROR. *Crown 8vo. 7s. 6d. net.*

Methuen's Half-Crown Novels

Crown 8vo.

Cheap Editions of many of the most Popular Novels of the day

Methuen's Two-Shilling Novels

Fcap. 8vo.

Write for Complete Lists